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EXPERIMENTS ON THE INCLINED PLANE.

The invention of Inclined Planes, and the successful experiments which have been made with them in overcoming great elevations, are but of recent date—more especially so in the United States. As far as their principles are known, and their practical utility tested by actual experiment, they cannot but be regarded as a great improvement. A great deal of expense is saved in constructing canals, and besides, the difference of the time of boats in passing from the upper to the lower, and from the lower to the upper levels, where the elevation is great, will render the navigation from one end of the canal to the other, much more expeditious and sure.

The Inclined Plane at this place has a rise of 70 feet in a length of 770; but the extreme length of the ways is 1040 feet. The ascent is uniform from the surface of the water in the lower level, to the height of that in the upper, at which point the summit curve commences, and the ways, after rising one foot higher, descend into the water of the upper level. There are two pair of tracks, on each of which is a car of very strong construction, supported by eight wheels, so arranged that the car may nevertheless pass over the summit, and from one declivity to another, with an equal bearing on the whole eight. The cars are connected with the machinery by cable chains, capable of bearing a strain of fifteen tons without alteration, and which have actually been proved to that degree. Upward of twenty tons are required to break them. The strain put upon them by the operation of the Plane is calculated never to exceed six tons. The moving power is a water wheel of 24 feet diameter, which is placed a short distance down the declivity of the plane. In the ordinary condition of the plane, one car stands in the upper level, the other in the lower, and a boat may pass in either direction, or two boats in opposite directions at the same time. The first part of the operation is to draw the car out of the upper level by a separate action of the water wheel; as soon as it has passed the summit and begins to descend, the main machinery goes into action, and then the ascending car begins to move. The motions of the two reciprocate, until the descending car reaches the bottom of the plane, at which time the ascending one goes over the summit, and descends into the upper level by its own gravity, independently of the machinery. The boat, if there be one, is then sent forward with considerable velocity, and leaves the car without any effort on the part of the attendants or boatmen. The whole operation is performed with a degree of celerity, even beyond the calculation of the Engineer. It was performed about 60 times in the course of Friday and Saturday last, carrying boats variously loaded in twelve cases; and once with a boat ascending and another descending at the same time; the load of the ascending boat being about 21 tons. The time of the operation has generally been about eight minutes—sometimes less than seven—never more than nine. Five operations can with the greatest ease be performed in an hour, allowing large intervals for the entrance and exit of boats, and for other purposes, and as two boats may pass at each operation, the plane will accommodate the arrivals and departures of ten boats per hour, with a tonnage of 250 tons; or 6,000 tons per diem, which is nearly four times the whole commerce of the New York canals at Albany. The detention of the boat will not, according to the experiments, exceed seven minutes, (the remaining time on the plane being compensated by the motion forward,) which is only a detention of one minute for every ten feet of lift. This is a saving of at least nine-tenths in comparison of locks, and reduces the detention on the voyage from Easton to this place, from 24 hours, which it would be if locks were used, to less than two hours and a half. There are now three Inclined

Planes on Professor Douglas's principle, finished and in operation; the others are in a state of forwardness that warrants the expectation of their being done by the opening of navigation in the spring. All the masonry, and a large part of the carpenter's work are already completed, and very little remains to be done, except to place the machinery, which can be done without inconvenience in the course of the winter.

The experiments upon the Plane excited much interest, and called forth repeatedly the warmest plaudits of the spectators.

CHYMISTRY.—OF THE METALS.

Copper.—We are yet ignorant of the union of copper with the first combustible substances; particularly with azote, hydrogen, and carbon, with which it is even believed to be incapable of combining. All we know is, that hydrogen and carbon decompose the oxide of this metal, take from it its oygen, and reduce it to the metallick state, at a red heat.

Copper is capable of combining with most of the metals; and some of its alloys are of very great utility.

The alloy of gold and copper is easily formed by melting the two metals together. This alloy is much used, because copper has the property of increasing the hardness of gold, without injuring its colour. Indeed a little copper heightens the colour of gold, without diminishing its ductility.

This alloy is more fusible than gold, and is therefore used as a solder for that precious metal. Copper increases likewise the hardness of gold. According to Muschenbroek, the hardness of this alloy is a maximum, when it is composed of seven parts of gold, and one of copper. Gold alloyed with $\frac{1}{12}$th of pure copper, by Mr. Hatchett, was perfectly ductile, and of a fine yellow colour, inclining to red. Its specifick gravity was 17·157. This was below the mean. Hence the metals have suffered an expansion. Their bulk before union was 2732, after union 2798. So that $916\frac{2}{3}$ of gold, and $83\frac{1}{3}$ of copper, when united, instead of occupying the space of 1000, as would happen were there no expansion, become 1024.

Gold coin, sterling or standard gold, consists of pure gold alloyed with $\frac{1}{12}$ of some other metal. The metal used is always either copper or silver, or a mixture of both, as is most common in British coin. Now it appears, that when gold is made standard by a mixture of equal weights of silver and copper, that the expansion is greater then when the copper alone is used, though the specifick gravity of gold alloyed with silver differs but little from the mean. The specifick gravity of gold alloyed with $\frac{1}{24}$th of silver and $\frac{1}{24}$th of copper was 17·344. The bulk of the metals before combination was 2700, after it 2767.* We learn from the experiments of Mr. Hatchett, that our standard gold suffers less from friction than pure gold, or gold made standard by any other metal besides silver and copper; and that the stamp is not so liable to be obliterated as in pure gold. It therefore answers better for coin. A pound of standard gold is coined into $44\frac{1}{2}$ guineas, or $46\frac{7}{10}$ sovereigns.

Platinum may be alloyed with copper by fusion, but a strong heat is necessary. The alloy is ductile, hard, takes a fine polish, and is not liable to tarnish. This alloy has been employed with advantage for composing the mirrors of reflecting telescopes. The platinum dilutes the colour of the copper very much, and even destroys it, unless it be used sparingly. For the experiments made upon it we are indebted to Dr. Lewis. Strauss has lately proposed a method of coating copper vessels with platinum instead of tin; it consists in rubbing an amalgam of platinum over the copper, and then exposing it to the proper heat.

Silver is easily alloyed with copper by fusion. The compound is harder and more sonorous than silver, and retains its white colour even when the proportion of copper exceeds one-half. The hardness is a maximum when the copper amounts to one-fifth of the silver. The standard or sterling silver of Britain, of which coin is made, is a compound of $12\frac{1}{2}$ silver, and one copper. Its specifick gravity after simple fusion is 10·200. By calculation it should be 11·33. Hence it follows that the alloy expands, as is the case with gold when united to copper. A pound of standard silver is coined into 66 shillings.

Mercury acts but feebly upon copper, and does not dissolve it while cold; but if a small stream of melted copper be cautiously poured into mercury, heated nearly to the boiling point, the two metals combine, and form a soft white amalgam.

There is no metal more useful than cop-

* The first guineas coined were made standard by silver; afterwards copper was added to make up for the deficiency of the alloy; and as the proportion of the silver and copper varies, the specifick gravity of [English] gold coin varies also.

per, excepting iron, to which it yields the superiority. Every one knows that a great number of instruments and utensils are made of copper for various purposes. Those vessels which are to be placed upon the fire are generally made of it, as it is much less liable to alteration than iron, and at the same time much more easy to be wrought. Its alloys with zinc and tin are employed for a great number of purposes in the arts, and in common life. But, unfortunately, this metal acts as a poison upon the animal economy; and it is one of the bodies that most threaten our existence. It is therefore much to be wished that it were prescribed, at least for economical and domestick uses. Cisterns, reservoirs, pipes, and cocks, made of this metal, or its alloys, are no less dangerous than copper-pans; and frequently they are even more pernicious, as they are not kept with the same care as the vessels, the whole of which is exposed to view at once, and which are employed several times a day. Too much care, attention, and prudence, cannot be employed in the use of all utensils made of copper, as all its oxides are extremely susceptible of dissolving in fat, oils, and most of the unctuous substances that are employed in the preparation of food. Frequent tinning is the most certain defence against this terrible evil.

Besides the varied and multiplied uses of copper in the metallick form, several ores and preparations of this metal are employed in a great number of the arts. The pyrites sulphurets serve for the preparation of the sulphate of copper, by their spontaneous efflorescence and their lixiviation; it is also prepared by burning a mixture of sulphur and copper. The malachites are cut and polished for trinkets; copper is continually alloyed with zinc and tin for making brass, casting statues, bells, pieces of artillery, &c. Its different salts and oxides enter into the preparation of colours for painting; of the baths; the preparations and mordants for dyeing; of enamels and glazings for pottery and porcelain; and of coloured glasses.

Iron.—Iron is the most important and most useful of all metallick substances. Without this metal no art could have arisen; man had remained in the savage state, and disputed for his food by brute strength with the other animals. Without this metal, agriculture could not have existed, nor could the plough have rendered the earth fertile. Without iron, all the other metals would have been of no utility; for it is by means of this agent that they receive their varied forms and dimensions. Iron alone may be considered as the representative of every other metal; it may be substituted in the place of any of them, but no metal can afford a substitute for iron. Though the scarcity, the brilliancy, and durability of gold and silver may place them in a higher rank in these respects, yet the service which iron renders to society entitles it to a higher degree of estimation in the minds of men, who are accustomed to think with justice and propriety. It is true, that it does not shine with a splendour equally strong; nature has not decorated it with so beautiful a colour, but its intimate properties are much more precious. All the other metals might, in truth, be dispensed with; but iron, on the contrary, is indispensible and necessary. The condition of humanity would be truly miserable without this metal, as is proved by the history of those people with whom the art of working it is still unknown, and who, with joy and exultation, exchange the gold with which their country is enriched for morsels of iron, which happier and more cultivated nations bring to them in exchange. Iron composes the first instrument of machines, and the first mover of mechanicks. In the hands of men it governs, and, as it were, subdues all the products of nature. In successive obedience to his power, we behold it change the form and properties of other bodies, by the perpetual influence it exercises upon them. In a word, it is the soul of all the arts, and the source of almost every beneficial product.

Though a thousand facts in history prove that the ancients were not acquainted with the art of working iron like the modern nations, the historians of chymistry have nevertheless placed the infancy of their science among the first operators at the forge, whose existence they have admitted almost in the first ages of the world.

The alchymists qualified iron with the name of Mars, by consecrating it to the god of war, in whose service it has been much employed. From the denomination of Mars given to iron, naturally flowed the appellation *martial*, which has been successively attributed to numerous preparations made with this metal.

Iron possesses a peculiar metallick brilliancy. When we wish to describe its colour, we are obliged to say that it is white, rather livid, inclined to grey and to blue.

In its texture it is formed of small fibrous threads, or small grains and small plates very pointed. When examined with the microscope, it presents a great number of pores or small cavities, more perceptible than in copper. It appears that its interior texture, as shewn in its fracture, which is more or less fibrous, granulated or lamellated, depends much on the method of its cooling, the pressure it has undergone, the manner of treatment, and the heat under which it has been forged or struck.

The specifick gravity of iron varies from 7·600 to 7·800. Its hardness exceeds that of any other metal, and on this account it is used to grind, cut, fashion, engrave, and file most natural bodies, stones, wood, and particularly the other metals. It is also the most elastick of metals, and is therefore preferred to all the others for springs of every description.

The ductility of iron is also very considerable; but it is in some sort of a particular kind, or rather it is limited by its excessive hardness, or the cohesion of its particles. Though these adhere much more strongly than most of the other metallick substances, it cannot be made into plates as thin as are formed of several other of the latter; the thinnest sheet iron is in fact much thicker than very coarse leaves of lead or tin. For this reason iron is commonly placed in the fourth rank among metals as to its ductility, and this place is given on account of its ductility in the wire-drawers' plates. Its malleability is very limited, on account of its firmness, so that its ductility is much more eminent and remarkable. A wire of this metal, of one-tenth of an inch in diameter, supports a weight of four hundred and fifty pounds before it breaks, which cannot be done with any other metal, not even copper and platina, which approach the nearest to it. Muschenbroek, by examining a parallellopipedon of iron, of one-tenth of an inch in diameter, was obliged to use a force of seven hundred and forty pounds to break it; and he remarks on this occasion, that a similar piece of iron, forged of horse-shoe nails, which had remained for some time in the hoof of a horse, did not exhibit a greater tenacity. This opinion is therefore a prejudice which arises only from the goodness and purity of iron made use of for forging those nails. When heated to about 158° of Wedgewood's pyrometer, as Sir George M'Kenzie has ascertained, it melts. This temperature being nearly the highest to which it can be raised; it has been impossible to ascertain the point at which this melted metal begins to boil and evaporate. Neither has the form of its crystals been examined: but it is well known that the texture of iron is fibrous; that is, it appears, when broken, to be composed of a number of fibres or strings, bundled together.

Iron is rapidly penetrated by the electrick fluid; it is one of the best conductors of electricity; and accordingly, since the discoveries of Franklin on the identity of atmospherick thunder and electrick spark, it is employed with great success to fabricate those elevated conductors, which are appropriated by their gilded and unalterable terminations in a point, to attract without noise, and rapidly to transport the electrick matter into the earth or into water, where their inferior extremities terminate. It has been long observed, that iron, thus vertically placed in an elevated situation of the atmosphere, if it remains a long time, or be struck with the electrick fluid of lightning, it assumes the properties of a magnet. If iron be struck in the air by the electrick shock, it takes fire; but as this phenomenon belongs to the history of its combustion, we shall speak of it in another place.

Magnetism is one of the most characteristick, and, at the same time, most singular of the properties of iron. It was long supposed to be peculiar to this metal; but it is not well known, that cobalt and nickel also possess it. Nevertheless, all the experiments relative to the magnetism of these two last metals not having been made either with the same accuracy, or to the same extent, as upon iron, the principal phenomena of this force have been well observed only in the latter metal.

The taste and smell are also two very distinct and very evident properties in iron. If we hold a piece of iron for some time in the hand, and afterwards hold it a little distance from the nose, we may discern its odour and quality.

When exposed to the air, its surface is soon tarnished, and it is gradually changed into a brown or yellow powder, well known under the name of rust. This change takes place more rapidly if the atmosphere be moist. It is occasioned by the gradual combination of the iron with the oxygen of the atmosphere, for which it has a very strong affinity.

Carburet of iron is found native, and has been long known under the names of *plum-*

lago and *black lead*. It is of a dark iron grey or blue colour, and has something of a metallick lustre. It has a greasy feel, is soft, and blackens the fingers, or any other substance to which it is applied. It is found in many parts of the world, especially in Britain,* where it is manufactured into pencils. It is not affected by the most violent heat as long as air is excluded, nor is it in the least altered by simple exposure to the air or to water. A moderate heat produces no effect upon it, and occasions but little change in its bulk. It is used, therefore, in making the crucibles called *black lead*. It was long supposed to be incombustible.

Tin.—Tin is one of the metals which was earliest known, and of which the discovery must have been among the first which was made by men; at least, its discovery appears to be hidden in the darkness of ancient times, even beyond those of fabulous history. The Egyptians made great use of it in their arts; and the Greeks alloyed it with other metals. Pliny, without composing an accurate history, or precisely comparing its qualities with other metals, speaks of it as a metal well known, and much employed in the arts, and even applied to a great number of the ornaments of luxury. He often calls it white lead, and points out its frequent and fraudulent contamination with black lead, or lead properly so called.

The alchymists attended greatly to tin; they named it Jupiter, and have distinguished its various preparations by the name of Jovial.

Pure tin is of a white colour, equal in beauty and brilliancy to that of silver; and if this colour were not changeable, it would be as valuable as silver. It was formerly considered as the lightest of metals, when a distinct and particular class was made of the semi-metals. Its specifick gravity varies from 7·291 to 7·500, according as it is hammered or not.

It is one of the softest of metals. It may be easily scratched with the nail; and and there is scarcely any other metal which cannot injure its surface by pressure or by friction. A knife readily cuts it; it may be easily bended, and when bended, affords a peculiar crackling noise. In this property it has been compared to zinc; but the noise is very different, or much weaker, in zinc than in tin.

*The chief mines are at Keswick in Cumberland and in Airshire.

This phenomenon appears to depend on a separation of its parts, and the sudden fracture which they suffer by the bending, though tin is not easily broken. Its sonorous quality is feeble; its ductility is sufficient to admit of its being reduced by the hammer, or laminating cylinder, into very thin leaves, which are of great use in the arts. It holds the fifth rank among metals in this property. It has little elasticity or tenacity; a wire of this metal of $\frac{1}{10}$ of an inch in diameter supports, without breaking, a weight of 50 pounds.

Tin is one of the most dilatable of metals by calorick, according to the experiments of Muschenbroek.

It is also a good conductor of heat. After mercury, it is the most fusible of all the metals. It comes immediately before bismuth and lead in this respect; its melting point is 440° of Fahrenheits's scale. When fused, it does not rise in vapour, but at a very elavated temperature; it has ever been considered as one of the most fixed of metals; on which account the alchymists thought it considerably resembled silver. If it be suffered to cool slowly, and when its surface is congealed, it be pierced, and the part which is still fluid be carefully poured out, the interior presents crystals in rhombs of considerable size, formed by the assemblage of a great number of small needles longitudinally united.

Tin is a very good conductor of electricity and galvanism, and is frequently used for covering conductors, and for Leyden bottles. It has a very remarkable odour, with which it impregnates the hands and bodies rubbed with it. Its taste is also very sensible, and it also possesses very powerful medicinal properties.

Tin is not very abundant in the bowels of the earth, at least in Europe. The most abundant mines are in Cornwall, Bohemia, and Saxony. The most skilful mineralogists have hitherto distinguished only three species of tin ores; namely, native tin, its oxide, and its sulphuretted oxide.

Tin is not easily oxidized in the air without heat, but it soon loses its bright and beautiful white colour. When cut, it is as brilliant and as clear as silver; but in a few hours this fine colour changes, becomes dull, and in a few days becomes tarnished. Long exposure to the air considerably increases this alteration, though it takes place only at the surface; so that at last it becomes of a dirty grey, without any brilliancy, and is covered with a light stratum of grey ox-

ide. It is, therefore, necessary that vessels of tin should be frequently cleaned and brightened to renew their surface and retain their beauty. But this weak oxidation never penetrates so deeply as to justify the assertion that tin like other metals, rusts in the air.

When tin is fused with the contact of the air, the metal, when scarcely liquefied, becomes covered with a dull grey pellicle, which becomes wrinkled, and separates from the portion of fused tin. When this pellicle is detached, another is formed; and by proceeding in the same manner, the whole of the tin may be converted into pellicles.

In the art of casting and purifying tin vessels, this oxidized matter, formed at the surface of the metal in fusion, was called dross; and it is very evident that it is in the power of the founder, to convert all the tin into dross; he consequently did not lose this pretended impurity, but knew very well how to recover it again in its metallick form, by heating it with tallow or resin. This crust is, therefore, a true grey oxide of tin; the metal contains from eight to ten per cent. of oxygen, and it is easily reduced. If tin be continually heated with the contact of air, particularly with agitation, it becomes divided, attenuated, and is changed into a powder, which gradually becomes white, with increase of weight, is more oxidized, and constitutes what is called putty of tin in the arts.

SPRINGS AND ARTIFICIAL FOUNTAINS.

Springs and Artificial Fountains.—From the Annales de la Societe D'Horticulture de Paris.—Considerations, Geological and Physical on the reservoirs of subterranean water, relative to the spouting fountains of wells, obtained by boring; by M. Le Vicomte Hericart De Thury, President of the Horticultural Society of Paris.—Translated for Prof. Silliman's Journal, by Gen. H. A. S. Dearborn, Brinley Place, Roxbury, Massachusetts.

Water is every where elevated in the atmosphere by evaporation.

A part of the mist, dew, snow and rain falling on the mountains, appears to act by affinity upon the clouds, and to collect them around their summits.

Thus arrested and concentrated about the mountains, the waters infiltrate between their different superpositions. They follow their declivities or inclinations, until they meet impermeable strata, which retain them, upon which they flow subterraneously, and whence they pour or spout out, whenever these strata present any opening, especially on the flanks of the mountains and hills, where these strata are broken and denuded by some convulsion.

Besides, there exist springs upon the elevated plains and even on the hills which are more lofty than the surrounding country: for example, the perpetual springs of Mount Cimone, near Modene, are more elevated than all the country which surrounds them.

In primordial formations or primitive mountains, subterranean infiltrations are very rare, nevertheless springs are frequently found, but generally not very copious; still the borings which have been made, prove that the water infiltrates through them, as in the secondary and transition mountains, either between the superpositions of the different strata, which constitute them, or by the veins and crevices by which these mountains are often cut in all directions, and even to a very great depth.

Commonly, the overflowings of rain water, or from the melting of the snow, do not take place in primitive countries, but on the surface of the mountains, their masses being generally too dense and compact to permit any infiltration.

The waters which are found in the primitive earths vary in quality, like the earths which conceal them.

Those which flow to the surface are generally good, fresh and salubrious.

Those which infiltre between their superpositions, appear to partake of the nature of the different substances, which they encounter and traverse.

In the excavations, made by miners in the primitive mountains, springs of water are sometimes found, of a pure and excellent quality. Such are the springs which the veins of Chalanches, Gardette, Grave and St. Christophe, in Oisans, of the department of Isere, present; such are also, according to Cordier, the waters of Vic in Carlodes, at the foot of the Cantal, which issue immediately from the granite, and which are almost pure.

Generally the waters which flow from granitick earths are gaseous, sulphureous, and saline.*

When they are found in compact granite,

* This is not true in the United States.

these waters should have their origin in these rocks, or below them.

These waters are almost all thermal, and even of a very high temperature. Such, in France, are the thermal and gaseous waters of Ar, department of Ariege, of Chaudes, Aigues, near St. Flour in the Cantal; of Vals, near Aubenas, in Ardeche; of Bonnes, valley of Assan, Hautes, Pyrenees: of Cauterets, Hautes Pyrenees; of Bagneres de Luchon, Haute Garonne; which issue from granitick mountains, at a temperature which varies fom 30 to 90 degrees.

In the juxtaposition of the secondary formation, or of the depositions upon the primitive, there are frequently found abundant infiltrations, which not being able to penetrate the very compact mass of the latter, follow, subterraneously, the parts or surfaces under the secondary. The examples of these infiltrations, are very numerous, in the chains of the Alps and Pyrenees, and in all lofty mountains.

These infiltrations being thus formed, in the most elevated parts of the chains of mountains, extend under the earth, for distances and depths, whose limits it is impossible to determine.

The waters of these fountains are generally fresh and of a good quality, when they are near the surface of the earth.

When waters are procured from a great depth, they are almost always gaseous, sulphureous and saline.

The secondary mountains and their form of superposition, allow the waters to penetrate to much greater depths than the primitive mountains.

They follow, in secondary formations, the dip, more or less inclined, of the beds or strata of their different formations.

The waters of these formations are those which present the greatest varieties in their character. It is, in fact, in these formations that are found the greatest number of the mineral and thermal springs, and the saline and gaseous waters.

These waters, although issuing from secondary formations, do not always appertain to them, and many of them probably proceed from primordial formations, which are situated below them. It is to these formations that it is proper to refer the waters of Cambo, in the Bosses Pyrenees; of Vicky, of Bourbon l'Archamboud, of Neris, department d'Allien; of Bourbon Lancy, department of the Saone et Loire; of Cramsoc, Sansoi, in Aveyron, of Bagneres de Bigorne, Hautes Pyrenees; of Ussat, near Tarascon, Ariege; of Bagnoles, near Mende, Lozene; of Leuxeuil, near Vesoul, Haute Saone, and Plombieres, near Remiremont, in Vorges, &c.

Fresh water, of a good quality and very abundant, is also found in these formations, which issue from the earth with impetuosity, and often present this peculiarity: that they spout up in the vicinity of gaseous, mineral and thermal waters, and that they often flow together, through the same aperture, although it is very certain, they have their origin in different formations. This phenomenon is very frequent in those countries where saline springs exist, and it is sometimes very difficult to separate the springs of fresh and saline waters.

The Alpine calcareous mountains, those of *calcaire jurassique* (limestone of the Jura; transition Limestone) and the depositions which cover their base, contain, like the primary, very different waters as to their nature, quality and temperature.

We find abundant fresh water, often forming very strong and rapid currents, which give existence to certain remarkable springs, such as those of Vaucluse, of Laise, of l'Orbe, &c.

We find mineral and gaseous, thermal and saline springs, such as those of Campagne, near Limaux Aude of St. Felix de Babneres, near Condat, Lot; of Aix, Bouchede, Rhone; of Greou, near Digne, Basse-Alps, of Balaruc, near Montpelier, Herault; of Bourbonne les Buns, Haute Marine; of Chateau Salins, Salins in Meurthe and gurn; of Paugues in Nievre; of Paint Amond, near Valenciennes, Nord, &c. &c.

The superior oolite and chalky calcareous depositions and formations; argillaceous and sandy depositions, coarse limestone, the marles, the fresh water limestone, or, (belonging to the) *terrain lacustre* are more favourable than the preceding to the infiltration of waters, which descend from greater elevations. These formations present abundant waters in the superpositions; they have a constant analogy in their composition and properties. The predominant salts are the carbonate and sulphate of lime, the sulphate and carbonate of iron, and sometimes the sulphate of magnesia; when they are filtered through chalky or sandy masses, these waters are generally fresh and of a good quality.

They are ferruginous when they pass and infilter through, pyritous earths, or mines of iron, or through pyritous argillaceous earths, such as those of Passy, near

Paris, and of Forges, in the Seine. Inferieure, or those of Ferrienes, near Montargis, and of Segrais, near Pishiviers, which issue from superior formations to coarse marine limestone.

The only example of sulphureous water, well attested, at this time, in earths of this formation, is that which the waters of Enghien present, containing sulphuretted hydrogen gas, the sulphate and muriate of magnesia, the sulphate and muriate of lime, &c. &c.

Generally, the waters of all these earths are of the mean temperature of the place where they gush out, and are that which is called *cold*, in opposition to the *thermal* waters.

Alluvial earths, like the preceding, yield abundant fresh water.

Generally, their waters proceed from the filtration of rain and melting snow, which penetrate, extend and flow between the beds of marl, clay, or sand, where we attempt to reach them by our wells.

The alluvial earths, of alluvial sand and gravel, sometimes present natural fountains, which indubitably proceed from more elevated districts, and probably from secondary or primary earths; such are the fountains of Moses, near Suez, described by Monge, situated on the summit of small sandy hills, raised by the winds, and aggregated by the sulphate of lime, which the waters of these fountains hold in dissolution; such is that fountain of fresh water, flowing above the waves of the Mediterranean, near Spezzia, and described by Spallanzani; such is the beautiful spring, in the sand bank, on the shore of Alvarado, in the gulf of Mexico: this sand bank, forty years since, was not more than 0.66 centimetres high, and about half a mile in area; now, by successive accumulations, this sand bank forms a hill more than thirty metres in height, where the inhabitants of Alvarado and the crews of the vessels, which frequent this port, daily go to procure water from the spring flowing at its summit, which is fresh and of a good quality; finally, such is the spring of Lairet, at the chateau of the *Source-Morogues*, near Orleans, which rises from a very deep pit, formed of sand on its borders, and of rock at the bottom, and which yields a volume of water of more than thirty cubick metres.

Volcanick earths and those of *trachyte*, which are now generally considered as having been thrown out from below the granite, by the action of subterranean fires, afford springs of fresh water, which proceed from infiltrations; their superior parts often present lakes and other large collections of water. Among the numerous examples which we are able to cite, there are none, perhaps, more remarkable, than the beautiful springs in the grotto of Royat, which supply the fountains of Clermont. Few countries afford so many springs, as the volcanick mountains of Pay de Dome and of Cantal.

The *terrains de trachyte* and volcanick ejections contain many mineral and thermal springs, which present, in their temperature and composition, the same characteristicks as those of the primitive earths: thus these waters are more or less charged with sulphuretted hydrogen, carbonick acid, carbonate of soda, and lime, of silex, &c.; such are those of Mont d'Or, Saint Allyre, Viele-Comte, Chatel-Guyon, near Rion, Chap des Beaufort, and Chalusset, &c. &c.; the two last are remarkable for the quantity of carbonick acid gas, which is disengaged from the earth, from which they issue. As to those of Deux-Landes, which issue from trap rocks, covered by compact calcareous formations, they present this peculiarity, that at a temperature of 60°, they are almost pure, and contain but a very small quantity of magnesia and sulphate of soda.

According to some natural philosophers, the theory of the waters rising above the surface of the earth, through perforations made by boring with an auger, has sometimes been considered as analogous to that of jets d'eau, and at others, to that of the syphon. The shaft made by boring, they say, being only the second branch of a great syphon, whose first branch is the subterranean spring, which flowing between the impermeable strata, these confined waters proceed from a more elevated region than that in which the boring has been excavated.

According to others, these shafts can and ought to be considered as tubes, which show the pressure of the water upon an earthy or stony bed, in which these shafts end.*

These two opinions appear to us equally admissible. In fact, the labours in exploring the mines and quarries, have taught us, that in certain kinds of formations the wa-

* Mineral and thermal waters, rise to the surface of the earth, from the interior of primitive formations in consequence of the disengagement of gas and compressed vapors, which press and rest upon the surface of these subterranean waters. This has been perfectly demonstrated by M. Berthier, chief engineer of the mines.

ters are subterraneously diffused in veins, streams, and sometimes even in torrents, more or less powerful, through the crevices, fissures and natural perforations of the interior of the bed of rock; while in other kinds of formations, the waters form level sheets, more or less abundant, between the beds of sand, of earth, or of stone, permeable and impermeable.

The grand calcareous masses of the chains of the Alps and of Jura, present numerous examples of these torrents, or subterranean streams, which have their sources or origin in the high mountains, and which after a longer or shorter course, form the admirable fountains of Vaucluse, Laisse, l'Orbe, Sassenage, &c. &c. Some quarries in Paris and the environs, offer frequent examples of vestiges of streams, or subterranean currents, which have formerly passed through the calcareous mass, at different heights, by the means of fissures and crevices, which generally intersect it in all directions.

The manner in which the springs exist, which are extended along the declivities of hills, to an almost constant height, in formations and beds, particularly in those of alternate formations of sand and clay, establish and characterize this disposition of the waters, which we have said is in a *sheet*, and whose origin is attributable, either to the subterranean effusions, which proceed from more elevated regions, or to the infiltrations of snow and rain water, which are arrested by these beds of clay.

This *sheet* of water has been assimilated to a bed of clay, of sand, or of chalk. If the water is considered as placed between two curved surfaces, like two cups or basins, of different diameters, whose superior borders shall be in the same plain, or irregularly denticulated, or in part closed, the liquidity of the water is the cause of the pressure, which the tube formed by boring measures; but if it is supposed that instead of a *sheet* of liquid water, it was a sheet of ice, the pressure would be resisted, and would not be indicated by the tube, but it would be changed into a force of cohesion.

When the waters, whatever besides be their manner of extension, subterraneously, in descending from the superior regions toward the inferior, either in veins, streams or torrents, or in a level *sheet*, happen to meet any outlet in the earth, they enter it and are elevated to a height equal to the level, *or point of departure*, or in other words, to a height which balances the pressure which the water exerts against the sides of the channel which contains it.

Whence it follows, that to obtain a fountain, which shall rise to the surface, it is necessary, 1st, to endeavour, according to the nature of the earth, at a greater or less depth, to meet an effusion of water descending from superior basins, flowing in the bosom of the earth, between compact and impermeable beds; 2d, give to this water, by the aid of a tube formed by boring, the possibility of rising to a height proportioned to that of the level from whence it proceeds; and 3d, prevent, by metallick tubes forced down the shaft, the escape of the ascending water through sand, crevices, or fissures of the earth, traversed by the perforation made by the auger.

And from whence it is perceived, that water can be made to rise to the surface, by the aid of the auger, in almost every country which presents in the structure of its formations, *sheets* of subterranean water, between the alternate and continued superpositions of permeable or impermeable beds, extending to the regions or mountains, which conceal the reservoirs of these sheets of water, and whose bases or declivities are covered by these superpositions.

But nevertheless it is possible that a second shaft, bored a little distance from another, which affords water, would not yield any, if this last was supplied by a subterranean current, instead of a *sheet* of water, or if it was pierced upon the extremity of an elevated bed, supported against a formation of a different nature.

Explanation of the Plate.—Whatever be the origin of the water produced by a shaft made by boring, whether it proceed from a sheet of subterranean water, or results from a subterranean stream or current, the explanation can be sought in the theory of jets d'eau, or in that of the syphon.

In fact, natural overflowing fountains are always formed, when there exists a superior basin, from which the water can flow, through natural channels; it is seen:

1st. That a shaft, formed by boring, is really but an artificial issue, differing only from these natural conduits, by the regularity of its sides and direction, which tend to facilitate the ascent of the water;

2d. That the success of boring will be much more certain, when attempted in a region composed of impermeable strata, separated by beds of sand or gravel, through which infiltrate the effusions of a volume of subterranean water, or of superior basins.

And 3d, that there are fewer chances of success, in compact and entirely impermeable formations, which afford only streams or subterranean currents, which escape through the crevices, fissures, or irregular perforations of beds, or strata of stone, and consequently rendering it uncertain what place to select for commencing boring.

The Plate represents the geological section of a region, in which the primitive formation is covered in one part, by transition, or intermediary formations, partly compact, and in part crystallized, disposed in inclined strata with crevices and fissures, which traverse these strata in different directions; and in another part with secondary depositions, and by horizontal alluvial beds, which rest against the intermediary and transition formations, and cover them deeply.

The superior parts of the region present, at different heights, basins, lakes, or rivers, A, B, C, sometimes placed upon the line of juxtaposition of the alluvial and transition formations, and sometimes on the last.

When the waters of these basins, lakes, or rivers, find crevices, fissures or drains, below their beds, they lose themselves, or infiltrate by these issues, and are subterraneously diffused, and form the sheets *aa*, *a'a'*, *bb'*, *b'b'*, in the sand or gravel, upon the clay or impermeable formations, or constituting irregular streams, as presented by the line of superposition *cc*, of transported earths upon those of deposition,—"*sediment.*"

The bored shafts A', A'' and A''', descend to the sheet of water *aa*, supplied by the effusions of the basin A, yielding in the shaft A' the ascending water, which reaches to the surface of the earth, while in the shaft A'' it spouts above, and in the shaft A''' it remains below the surface, rising in each of these perforations, at a height proportioned to that of the level of the basin A.

As to the shaft A'''' which is twice as deep as the preceding, notwithstanding its greater depth, and the two sheets of water which it has passed, (*aa* and *a'a'*,) the water does not rise higher than in the shafts A', A'', A''', because these two sheets of water are both supplied by the basin A.

It is the same with the shaft B. Finally, the shafts C', C'', C''', supplied by the irregular stream *cc*, which has its origin in the basin C, show, 1st, that the shaft C'', if it was only bored to the depth of the shaft C', would not yield water, because the stream pursued the irregular course of the surface of the inferior formation, and that it is necessary to bore deeper to reach the water at C''; and 2d, that the shaft C''', descending still lower, does not yield any at this depth, in consequence of the elevation of the intermediary, or transition formation which interrupt, in this part, the flowing of the stream *cc*, or that if this shaft afforded overflowing water, it would rise from the sheets *bb* and *b'b'*, which it had intersected, and that thus, notwithstanding the great depth of this shaft, the ascending water could never rise above that of the two shafts B', and B''.

NEW YORK CANAL TOLLS.

By the following statement of the tolls collected on the several canals in this State, from the Comptroller's Office, it will be perceived that the tolls collected on the Erie and Champlain Canals during the season which has just terminated, amount to one million, twenty-nine thousand, nine hundred and thirty-two dollars; exceeding by a quarter of a million the receipts of any previous year.

Erie and Champlain Canals.

	1829.	1830.	Increase.	Decrease.
Albany . . .	161,443 69	211,785 76	50,342 07	
West Troy .	85,259 46	124,560 31	39,300 85	
Schenectady	29,671 96	37,102 51	7,430 55	
Little Falls .	9,648 21	8,703 02		1,575 19
Utica	42,122 33	46,051 46	3,929 13	
Rome	23,956 78	28,802 71	4,845 93	
Syracuse . .	60,752 69	85,900 70	25,148 01	
Montezuma .	66,701 63	74,733 34	9,031 71	
Lyons	27,733 55	24,209 57		3,523 98
Palmyra . . .	44,845 71	48,064 63	3,218 92	
Rochester . .	98,518 17	149,800 55	51,362 38	
Albion	12,019 99	12,102 08	82 09	
Brockport . .	10,150 26	12,727 89	2,577 63	
Lockport . .	12,503 42	21,549 33	9,045 91	
Buffalo . . .	25,957 38	48,628 26	22,670 88	
Geneva . . .	11,402 43	31,477 40	20,074 97	
Waterford & Sloop Lock	17,234 48	10,464 37		6,770 11
Fort Edward	10,516 28	11,766 78	1,250 50	
Whitehall .	44,617 10	41,051 69		3,565 48
	$795,055 52	1,029,932 29		

Otsego Canal.

Salina	7,533 35	8,491 48	958,13
Oswego	1,906 09	3,609 12	1,703 03
	$9,439 44	12,100 60	2,661 16

Cayuga and Seneca Canal.

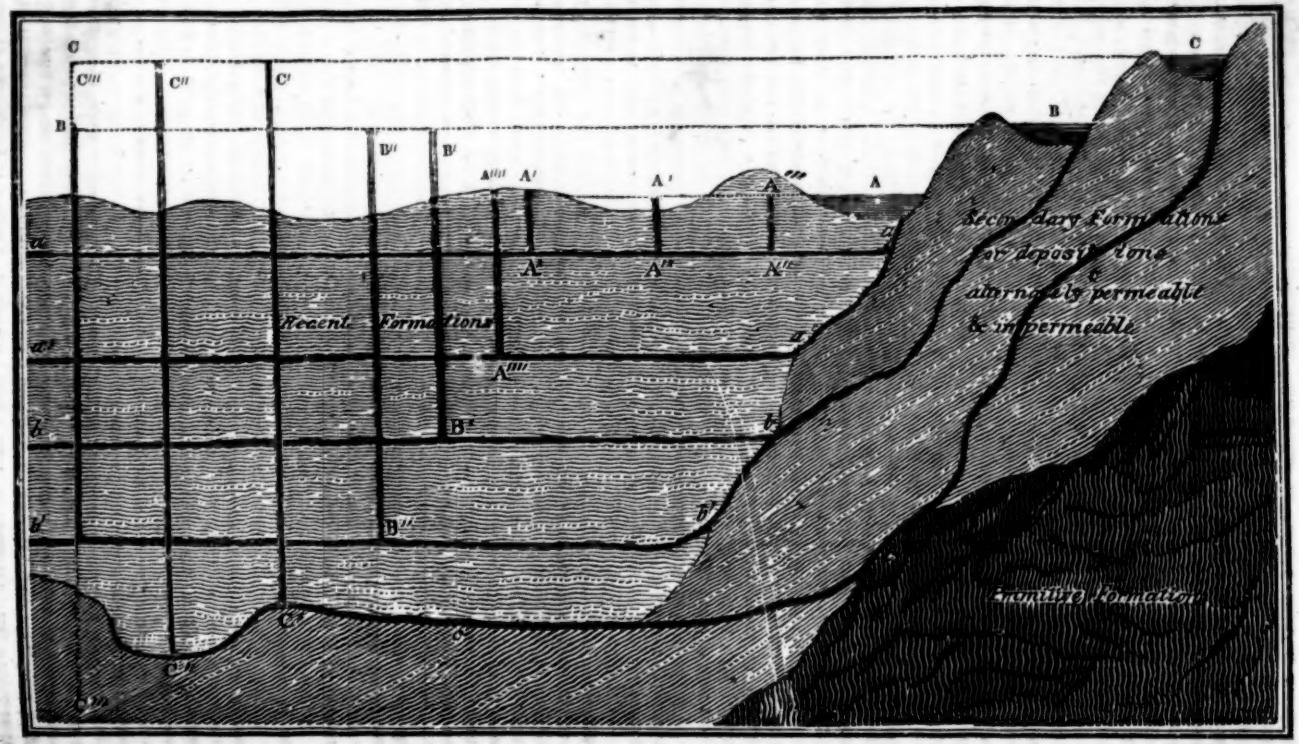
Montezuma . .	4,533 27	6,687 29	2,144 02
Geneva	4,100 22	5,214 58	1,114 36
	$8,643 49	11,901 87	3,258 38

Increase in 1830, on the Erie and Ch'n Canals, $234,876 77
Do. do. do. Oswego Canal, 2,664 16
Do. do. do. Cayuga and Seneca Canal, 3,258 38

From some of the collector's offices no statements of tolls collected have been received of a later date than the 7th inst. It is not known whether any collections have been made at those offices since that date; but from the receipts of other offices, it is certain that the sums collected, if any, must

THEORY OF SPRINGS AND FOUNTAINS.

(See opposite page.)



be very small, and will not materially vary the result as shown by the table. It should be also remarked, that the footing given for the Erie and Champlain Canals, includes the proportion of tolls due the proprietors of the Albany Basin, amounting to about $3,000.

LEAD,

Produced at the United States Lead Mines, annually from 1823, *to* 1829.

	Fever River.	Missouri.	Total.
1823,	335,130	. .	335,130
1824,	175,220	. .	175,220
1825,	664,530	386,590	1,051,120
1826,	958,842	1,374,962	2,333,804
1827,	5,182,180	910,380	6,092,560
1828,	11,105,810	1,205,920	12,311,730
1829,	13,343,150	1,198,160	14,541,310
Tot. lbs.	31,764,862	5,076,012	36,840,874

STEAM-BOAT TONNAGE,

In the different States, in 1827.

	Tons. 95ths.		Tons. 95ths
Maine . . .	350 00	Maryland . .	2,207 49
Rhode Island . .	178 07	Dist. Columbia	873 12
Connecticut	1,652 72	Virginia . .	946 57
New York .	10,264 88	South Carolina	3,233 79
New Jersey	1,078 92	Georgia . .	719 43
Pennsylvania	1,580 04	Alabama . .	3,100 21
Delaware . .	372 56	Louisiana .	17,003 37
	Total, 43,558 17		

LARGE BURNING GLASS.

Burning glasses, generally, are well known; the one we are about to mention, being of an uncommon size, may not be much known. The peculiarity of this instrument is its power of directing the rays of the sun to a particular point, or focus; as all the rays which fall upon the lens, are united in its focus, their effect ought to be so much the more, as the surface of the lens exceeds that of the focus. Thus, if a lens four inches broad collect the sun's rays into a focus at the distance of one foot, the mage will not be more than one-tenth of an inch broad. The surface of this little circle is 1600 times less than the surface of the lens, and consequently, the sun's rays must be ten times denser within that circle; it is not therefore surprising, that these rays burn with a degree of ardour and violence exceeding any culinary fire.

Mr. Parker's lens, of Fleet-street, London, is formed of flint-glass three feet diameter, and when fixed in its frame, exposes a clear surface of two feet, eight inches and a half in diameter; its weight is two hundred and twelve pounds; focal length, six feet 8 inches; diameter of the focus, one inch. A second lens was used, which reduced the focus to half an inch.

Some of the principal effects produced by this glass were as follows:

1. Every kind of wood took fire in an instant, whether hard or green, or soaked in water.

2. Iron plates grew hot in a moment, and then melted.

3. Tiles, slates, and all manner of earth became red in a moment, and vitrified.

4. Sulphur, pitch, and all resinous bodies, melted under water.

5. Fir-wood exposed to the focus, under water, did not seem changed, but when broken, the inside was burnt to coal.

6. If a cavity were made in a piece of charcoal, and the substances to be acted on were put in it, the effect of the lens was much increased.

7. Any metal whatsoever, thus enclosed in the cavity of a piece of charcoal, melted in a moment, the fire sparkling like that of a forge.

8. The ashes of wood, paper, linen, and all vegetable substances, were turned in a moment into a transparent glass.

9. The substances most difficult to be wrought on were those of a white colour.

10. All metals vitrified on a China plate, when it was so thick as not to melt, and the heat was gradually communicated.

11. When copper was thus melted, and thrown quickly in cold water, it produced so violent a shock, as broke the strongest earthen vessels, and the copper was entirely dissipated.

Observations.—1. Though the heat of the focus was so intense as to melt gold in a few seconds, yet there was no heat at a small distance from that focus; and the finger might be placed in the cone of rays within an inch of the focus, without receiving any hurt.

2. Mr. Parker had the curiosity to try what the sensation of burning at the focus was, and having put his finger there for that purpose, he says, it neither seemed like the burning of a fire, nor a candle, but the sensation was that of a sharp cut with a lancet.

3. You may, by means of a burning-glass, char or burn a piece of wood to a coal, in a decanter of water, and yet the sides of the decanter, through which the

rays pass so very near the focus, will not be cracked, nor any ways affected; nor will the water be in the least degree warmed. If the wood be taken out, and the rays thrown on the water, no continuance of collected rays in this way, will either heat the water or crack the glass; but if a piece of metal be put into the water, it soon becomes too hot to be touched, and communicating its heat to the water, makes it not only warm, but sometimes causes it to boil.

4. Though water alone be not affected, yet, if a little ink be thrown into it, the water will soon be heated.

EFFECT OF ODORIFEROUS EFFLUVIA ON INSECTS.

Sir,—An experiment which I made, only a few days back, so clearly illustrated how very obnoxious the odour of such simple perfumes as camphor, cedar shavings, dried lavender flowers, &c. is to insects, that I take the liberty of troubling you with the particulars of it for insertion in your valuable Magazine; it will show how useful such preservatives must be in every wardrobe and cabinet.

An insect, a species of gnat, the body of a pale pea-green colour, and its extreme measure not exceeding three quarters of an inch in length, was caught late in the evening, and placed under an inverted wine-glass. On the morning of the day following, a small slip of paper was folded up, one minim of essential oil of lavender dropped upon it, and then immediately placed under the wine-glass. The insect, after creeping about for a short time the previous evening, had settled on the roof of the inverted glass, where it remained, unmindful of the glass being disturbed till a minute or two had elapsed after the introduction of the essential oil. It now commenced drawing its feelers alternately between its fore-legs with a momentary increase of rapidity; it next moved about the upper part of the glass; it soon grew extremely uneasy, moving its head quickly towards and from the glass. In about ten minutes it partially descended the side and walked round, but in a little while longer it became much irritated, running to the bottom, fluttering its wings, pushing itself backwards, and then, as if revived by immersion in a stratum of purer air, it would attempt to re-ascend the side of the glass. It was curious to observe that every fresh attempt became more and more circumscribed, till at length it remained in great agitation at the bottom, sometimes crawling over the scented paper, but soon falling down much enfeebled, and constantly most overcome when in the vicinity of the oiled portion of the paper. Its motions towards the expiration of an hour's time became irregularly backwards and forwards with strong convulsive action, and in the course of the day it was found to be completely dead. No precautions were taken to prevent the access of air between the rim of the glass and the paper of the book on which it stood. It is plain from the foregoing, the reason why powerful perfumes are so offensive to even the larger insects, for here a single drop of essential oil was effectual, in a comparatively short time, in destroying a pretty large one, in healthy condition.

In no chymical or other work that has come under my observation, have I seen any notice of odoriferous effluvia having the power to destroy life as here described; in the event of any of your numerous circle of readers having met with intimation of the fact, I shall feel obliged by their communicating a short statement of the particulars. H. D.—(London Mech. Magazine.)

COMPRESSIBILITY OF LIQUIDS AND OTHER FLUIDS.

Liquids are compressible by mechanical force in so slight a degree, that they are considered in all hydrostatical treatises as incompressible fluids. They are, however, not absolutely incompressible, but yield slightly to very intense pressure. The question of the compressibility of liquids was raised at a remote period in the history of science. Nearly two centuries ago, an experiment was instituted at the Academy *del Cimento*, in Florence, to ascertain whether water be compressible. With this view, a hollow ball of gold was filled with the liquid, and the aperture exactly and firmly closed. The globe was then submitted to a very severe pressure, by which its figure was slightly changed. Now it is proved in geometry, that a globe has this peculiar property, that any change whatever in its figure must necessarily diminish its volume or contents. Hence it was inferred, that if the water did not issue through the pores of the gold, or burst the globe, its compressibility would be established. The result of the experiment was that the water *did* ooze through the pores, and covered the surface of the globe, presenting the appearance of dew, or of steam cooled by the metal. But this experiment was inconclu-

sive. It is quite true, that if the water *had not* escaped upon the change of figure of the globe, the *compressibility* of the liquid would have been established. The escape of the water does not, however, prove its *incompressibility*. To accomplish this, it would be necessary first to measure accurately the volume of water which transuded by compression, and next to measure the diminution of volume which the vessel suffered by its change of figure. If this diminution were greater than the volume of water which escaped, it would follow that the water remaining in the globe had been compressed, notwithstanding the escape of the remainder. But this could never be accomplished with the delicacy and exactitude necessary in such an experiment; and, consequently, as far as the question of the compressibility of water was concerned, nothing was proved. It forms, however, a very striking illustration of the porosity of so dense a substance as gold, and proves that its pores are larger than the elementary particles of water, since, they are capable of passing through them.

It has since been proved, that water, and other liquids, are compressible. In the year 1761, Canton communicated to the Royal Society the results of some experiments which proved this fact. He provided a glass tube with a bulb, and filled the bulb, and a part of the tube, with the liquid well purified from air. He then placed this in an apparatus called a condenser, by which he was enabled to submit the surface of the liquid in the tube to very intense pressure of condensed air. He found that the the level of the liquid in the tube fell in a very perceptible degree upon the application of the pressure. The same experiment established the fact, that liquids are *elastick*; for upon removing the pressure, the liquid rose to its original level, and therefore resumed its former dimensions.

Elasticity does not always accompany compressibility. If lead or iron be submitted to the hammer it may be hardened and diminished in its volume; but it will not resume its former volume after each stroke of the hammer.

There are some bodies which maintain the state of density in which they are commonly found by the continual agency of mechanical pressure; and such bodies are endued with a quality, in virtue of which they would enlarge their dimensions without limit, if the pressure which confines them were removed. Such bodies are called *elastick fluids* or *gases*, and always exist in the form of common air, in whose mechanical properties they participate. They are hence often called *aeriform fluids*.

Those who are provided with an air-pump can easily establish this property experimentally. Take a flaccid bladder, and place it under the glass receiver of an air-pump: by this instrument we shall be able to remove the air which surrounds the bladder under the receiver, so as to relieve the small quantity of air which is inclosed in the bladder from the pressure of the external air; when this is accomplished, the bladder will be observed to swell, as if it were inflated, and will be perfectly distended. The air contained in it, therefore, has a tendency to dilate, which takes effect when it ceases to be resisted by the pressure of surrounding air.

It has been stated that the increase or diminution of temperature is accompanied by an increase or diminution of volume. Related to this, there is another phenomenon too remarkable to pass unnoticed: it is the converse of the former; viz. that an increase or diminution of bulk is accompanied by a diminution or increase of temperature. As the application of heat from some foreign source produces an increase of dimensions, so if the dimensions be increased from any other cause, a corresponding portion of the heat which the body had before the enlargement, will be absorbed in the process, and the temperature will be thereby diminished. In the same way, since the abstraction of heat causes a diminution of volume, so if that diminution be caused by any other means, the body will *give out* the heat which in the other case was abstracted, and will rise in its temperature.

Numerous and well-known facts illustrate these observations. A smith by hammering a piece of bar iron, and thereby compressing it, will render it *red hot*. When air is violently compressed, it becomes so hot as to ignite cotton and other substances. An ingenious instrument for producing a light for domestick uses has been constructed, consisting of a small cylinder, in which a solid piston moves air-tight; a little tinder, or dry sponge, is attached to the bottom of the piston, which is then violently forced into the cylinder: the air between the bottom of the cylinder and the piston becomes intensely compressed, and evolves so much heat as to light the tinder.

In all the cases where friction or percussion produces heat or fire, it is because they are means of compression. The effects of flints, of pieces of wood rubbed together, the warmth produced by friction on the flesh, are all to be attributed to the same cause.

COMMUNICATION.] [FOR THE MAGAZINE.

MR. EDITOR,—The sensible remarks of your correspondent in your last number of the Magazine, concerning "Churns," recalled to my mind the number of patents granted for *Washing Machines and Ploughs*. On a recent visit to Washington, I could not help noticing the great number of these machines. The Patent Office is deluged with them, and it would puzzle the brains of many to discover the difference in the construction of a greater part of them. I understood that thousands of models of useful machines are thrown by and piled up as lumber, merely for the want of a larger hall for exhibition. Would it not be better to put by some of this useless "trash," to make room for the more useful machines? Would it not reflect more credit on our Government to provide a suitable building, large enough to contain all the models, and exhibit the drawings which accompany the specifications, which may be patented for a great number of years to come? As a publick office, owned by the Government, every citizen should have access to any of the drawings or descriptions which accompany the different kinds of patented machines. I understand the Patent Office contains many highly finished and elegant drawings, "which reflect great credit on their respective draftsmen." Would it not be a good plan to have an exhibition room, on purpose for the drawings, so that artists, in this branch of business, visiting the Patent Office, from the different sections of the country, may be edified by examining the drawings which have emanated from all parts of the United States? I looked in vain for models of many machines with which I was intimately acquainted, and which have been patented within a few years. The serious evils which accompany our patent laws, I hope one day to see remedied. I look forward to the time, when the claims of every industrious mechanick to his inventions shall not be wrested from him by the false representations of perjured men. Time will probably obliterate these evils, and every honest man may reap the reward for the benefits he may confer on his country. I need not mention what they are. You, and every body acquainted with the patent laws, must be aware of them. Hundreds have written on the subject, but as yet to no effect. But, Mr. Editor, we "live in hope." We can but hope Congress will one day correct these abuses. Our mechanicks do not enjoy the privileges of those in Europe. If a mechanick visits a foreign country, and notices any new and useful improvement, why may he not introduce it, and secure to himself the profits of the introduction by a patent? This the governments of Great Britain and France allow. Why must he "*swear*" that he is the "*original inventor*," if he but swears to the "*truth*," is not the country benefitted in the end? Some may oppose me on this point, I will allow. But there are arguments in favour of both sides. Since the introduction of cotton machinery, our country may be said to have outrivalled England, and to have almost arrived at "*perfection*." It gives us pleasure to see the rapid advances which science and the arts are making, and also to know that our country is large enough, and that we have not to fear any riots or disturbances among the spinners, such as occur in England, which we read of daily in the newspapers. The tide is impetuously rolling towards the "west," and a back country which is now a wilderness, will spring up in the course of a few years, to move with us in this great and glorious "march of improvement."

A Friend to the just rights of Mechanicks.

COMMUNICATION.] [FOR THE MAGAZINE.

METALLICK LETTERING OF SIGNS.

All is not gold that glistens.

MR. EDITOR,—With your permission, I would ask some of the readers of the Magazine, if they can assign a cause for the change of colour in the metallick lettering of most of the signs of our business people? This *phenomenon* has frequently astonished me; for instance, to-day my eyes have been gratified by the bright and lively colours displayed on the sign of a young tradesman—to-morrow, as it were, I have searched in vain for its former splendour!—it was not to be found; it had entirely vanished; and its place usurped by a very different looking article—which, were I to describe, I should say strongly bore the appearance of *copper*.

Now, sir, if some of your intelligent readers would throw a little light upon this subject, who knows but our signs, in future, *may be induced to hold their original colours*

a little better. This, I admit, is an insinuation, but the evil of which I speak will justify it. BRONZE.

[The evil of which our correspondent justly complains is very *apparent* in almost all parts of our city, and we hope some one, more able than ourself, will give an explanation of the *phenomena.* We are told by a manufacturer of the article of gold leaf, that he *can* and *does* make leaf which he will warrant not to fade. If such be the case, why do not our sign painters and gilders procure this unchangeable article, in preference to one which, in a few months, *reflects* much discredit to them ?—ED.]

COMMUNICATION.] [FOR THE MAGAZINE.

PRIVIES.

MR. EDITOR,—I think the plan of your correspondent, "Stercolanus," in your ninth number, concerning discharging the contents of privies into the sea, a very objectionable one. He could not certainly have reflected much on the subject, or he would not have advanced so singular an idea. It must be evident to every one that nothing could be so detrimental to the health of the inhabitants of the city. Our flats and low grounds would be worse than the celebrated Pontine marshes of Italy, or the swamps of Louisiana. If "Stercolanus" thinks the filth would be carried out to sea by the tide, he is greatly mistaken. A general deposition would take place in the docks of our wharves, and nothing would cause the depopulation of "whole streets and wards," or a larger "defalcation of income," more than this. I will admit, the health of many of our citizens is injured by the percolation of the fluid through the ground into the wells; but the fault does not lie in the height of the fluid in the vault, nor would it be remedied by having a "waste weir," or a sess-pool. I think, if a law should be passed by the city authorities ordering all vaults to be constructed of brick or stone, laid in cement, we should not have much to complain of impurities in our water. Every body recollects what an intolerable nuisance was created in different parts of the city, some years since, by discharging the contents of the night carts into the harbour. I am afraid, if the city government should adopt "Stercolanus'" project, that the business of our fishermen would soon begin to decline. "Stercolanus" says, "the saving to the citizens may be easily imagined, especially to the poorer classes, whose accomdations are the least perfect," &c. This certainly is absurd, for the effect would be just the reverse; the poorer citizens would be the greatest sufferers. Instead of a saving in the "doctor's bill," our physicians would be fully employed; the deadly *mularia* would soon make rapid progress, and our bills of mortality would be swelled with cases of intermittent fevers. E.

COMMUNICATION.] [FOR THE MAGAZINE.

IMPROVED DRAWING PEN.

MR. EDITOR,—Having made Linear drawing a part of my profession for some years past, it has frequently occurred to me that an improvement on the common drawing pen might be effected. We are apt, very often, in sharpening the pen, to get one lip a little longer than the other; in this case it will not make an even, but a ragged line. It then requires a great deal of time, perhaps, to make them both of the same length; and the chance is that we are able to effect it in nine cases out of ten; for, let us proceed ever so carefully with one lip, we may overshoot the mark, and instead of making it equal, get it shorter than the other. Every body who has had any experience in using the drawing pen, must be aware of this difficulty. I have frequently seen people who have spent a greater part of their lives as architects or draftsmen, and whose lines in their drawings were always coarse and uneven, merely from not understanding the art of sharpening their pens. The whole art of drawing fine and even lines consists in keeping the points of the pen sharp, and the lips of the same length. Some hold their pens perpendicular, others inclined a little towards or from them. It is evident that those who keep them inclined will wear one edge more than the other. As the pens are now made, they probably would be obliged to sharpen both points, and would perhaps waste a great deal of time in making the lips of the same length. The best method of sharpening is to wear a groove in the stone, by always rubbing the pen in the same place. The chance is then that both points may have very nearly the same breadth and the same convexity. A beginner is very likely to wear out a pen in a few months, while those more experienced would make one last a number of years. To remedy the evils I have spoken of, I have contrived a pen, the construction of which is shown in the annexed drawings

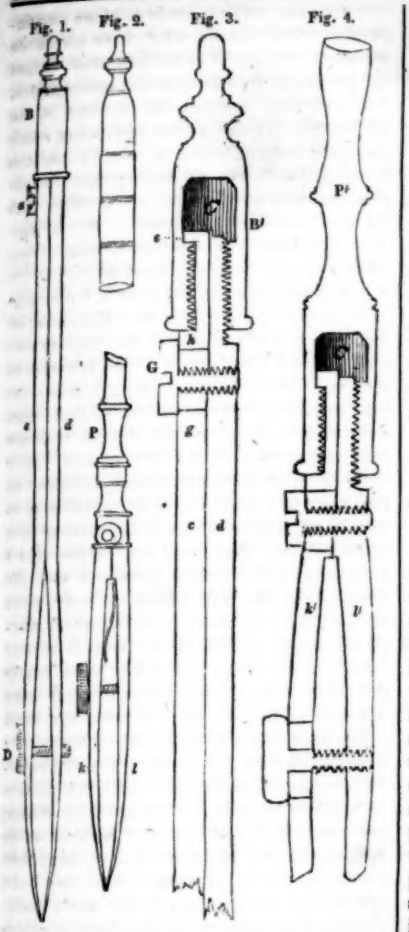


Fig. 1 (with the exception of the dotted screw head *a*) and Fig. 2, represent the two kinds of drawing pens most in use. The improvements which are to be applied to each, are shown in Fig.'s 3 and 4. As Fig. 1 is *now* constructed, a screw is cut on the end of the lips *c* and *d*, on which is screwed the brass cap B. In Fig. 3 it will be perceived that a chamber C is cut, the radius of which is larger than the interior radius of the screw, by the projection *e* on the lip *c*. The screw on the lip *c* is to be filed off down to its interior radius, and the projection *e* made on the end. The screw is left on the lip *d*. G is a screw for clamping the two lips; and a space *gh* is made in the lip *c*, of sufficient length to allow the "play" of the screw G, occasioned by the movement of the lip *d*. A similar space should be cut at D, Fig. 1. It will now be evident that when the screw G is loosened, and the brass cap B' is turned, the lip *d* will recede or advance, so that we can at any time perfectly adjust the lips *c* and *d* to the same length, and when the screw G is tightened, there can be no possibility of turning the cap B' by handling the pen, or by accidentally dropping it, or otherwise. In Fig. 4, *k'* and *l'* are lips similar to *k* and *l* in Fig. 2. The remaining parts need no description, as they are exactly like Fig. 3. I think that the advantages which the improved pens possess over the other kind, will be obvious to every one; and if some of our mathematical instrument makers would manufacture some, they would find a ready sale for them.

Your ob't servant,

ROBERT H. EDDY.

COMMUNICATION.] [FOR THE MAGAZINE.

VITALITY OF MATTER.

In the tenth number of the Mechanicks Magazine, there is an article on the vitality of matter, taken from Silliman's Journal. It seems to me that the theory which the author opposes is erroneous, but that some more arguments are wanting to refute it; I will therefore adduce a few. This theory, if I understand it, supposes each monad or atom, possessed of perception and appetite, that the principle of life is inherent in the elementary forms of matter, and that they assume new shapes, and revive in their primitive activity, whenever death changes their aspects. The chief argument in support of this theory is, that when certain substances are macerated so as to be undergoing decomposition, some small particles can be seen with a microscope, moving briskly. These particles are so small that their shape and movements cannot be distinctly seen with a microscope. Though I deny that vegetables and inorganick substances are always composed of a great number of animalcules, I would not have it understood that I suppose that animals which seem to be simple, are not sometimes composed of many small ones, or that a piece of animal matter does not sometimes become a perfect animal. In this case, the animal produced is like the one which the animal matter was a piece of: as in the case of a polypus, which being cut into several pieces, each piece becomes a distinct polypus, like the one which it was a piece of.

I will cite a case which seems to me like the chief argument, only that the particles

are so large that their shape and movements can be distinctly seen. When a few small pieces of camphor, as one quarter of a line in length, are laid on the surface of pure water, they will move briskly, some merely revolving, others moving crookedly along the surface of the water, &c. The smaller these particles are, the swifter they will move. This phenomenon is worthy the attention of the curious. I, not presuming, like some modern philosophers, that these pieces of camphor were real living animals, made many experiments to ascertain the cause of their motions; from which, I concluded that they are produced by the repulsive power of the particles of camphor. I will give some reasons in support of this conclusion, because I am not aware that this phenomenon has ever before been explicated. When camphor is exposed to the atmosphere, more especially when warm, small particles are continually flying off. Action and re-action being always equal and in contrary directions, it follows that when an atom flies off from a piece of camphor, that the piece is repulsed in a direction opposite to that of the particle which flies off; consequently, if one side of a piece of camphor be coated so that it may evaporate from only one side, the piece will be driven in a direction from that side from which it evaporates. This I find by experiment to be true. According to my theory, these particles should exert a repulsive force on whatever they impinge. This is also verified by experiment. When a small light substance is laid on the surface of water, and a piece of camphor placed near it, though not touching the water, the floating substance will be repelled from the camphor, though most commonly very slowly when the camphor is cold; but it may be made very perceptible by using a piece of warm camphor instead of cold. This motion is not produced merely by the warmth of the camphor, for if another warm body be brought near the floating substance, it will, by producing a motion of the air, draw the floating substance towards itself; or if a piece of burning camphor be brought near the floating substance, it will in the same way draw the floating substance towards itself. It is necessary that the water should be pure, that the pieces of camphor may move, as the presence of some substances will retard or stop the evaporation of the camphor, and consequently its motions; as, if the hundredth part of a grain of oil be dropped on the water where these bits of camphor are moving, their motions stop instantly. The reason why these pieces do not move when on a solid substance, is, that the friction is greater than the moving force.

I will next remind my readers of the wild oat, or live oat, whose motions so much resemble animal motions, as to cause it to be mistaken for an animal by those whose eyes are not very good, or by those who do not examine it closely. But I suppose that this is so familiar to most of my readers that I need not describe it.

I will next give an account of a phenomenon in which a hair seemed possessed of intellect, and of the power of voluntary motion. Some time since, I had occasion to remove a hair from a plane surface; the hair was long and crooked, so that some parts of it were at a considerable distance from the surface on which it rested. After making several unsuccessful attempts to brush it off, I put my hand towards it to pick it off, but as my hand approached it, it laid itself so closely to the surface that I could not get hold of it; when I took my hand away, the hair extended some parts of itself from the surface, as before; I moved my hand towards it and from it several times; the motions of the hair were nearly the same every time. I tried several times to catch it, but could not move my hand quick enough: I then thought I would try to get hold of it, by running a sharp pointed instrument between it and the surface on which it rested. I accordingly moved my hand, with a sharp steel instrument in it, towards the hair; when my hand had got almost to it, it darted from my hand and lit on another part of the same body, about a foot from the place from which it started. I at length got hold of it, took it away, and inadvertently let go of it; it immediately returned to the body from which I had taken it. I could not then explicate *all* of this by any laws of nature with which I was acquainted.—Is here not far better reasons for supposing that the hair was possessed of intellect, and of the power of locomotion, than for supposing that the particles of a decomposing substance are animals, merely because they stir, while these particles are so small that their movements cannot be distinctly seen? The substance on which the hair rested was an electrick, and at that time was charged with electricity. The motion of the hair from one part of the electrick to another, and its returning to the electrick after I had removed it, may be explicated by the well known

laws of electricity: the hair's laying close to the electrick when my hand approached it, was occasioned by electricity, but it is a phenomenon which I am not certain was ever noticed before, though I have since noticed it many times. These considerations should make us cautious in pronouncing any thing animated merely because it stirs, though its movements cannot be accounted for by any known laws.

I am aware that animals are sometimes found in matter, when it is difficult to conceive how they could have got there. I will cite a case which was for a while misunderstood. It was once believed by entomologists, that some caterpillars of a particular kind naturally changed into a great number of small flies, and that some of the same kind naturally changed into a large butterfly. The argument which supported this theory, is, that when these caterpillars were confined separately, in cells, so that nothing could get to or from them, after a certain length of time, in some of the cells, many small flies were found, and in others only one large butterfly. By examining these caterpillars with a microscope, it was found that there were many small worms in some of them; these worms destroyed the caterpillar, and in due time became flies. It is known that the food and education of some kinds of small animals influence their form and size very much; the growth of honey bees is a well known instance of this; either a queen or a working bee may be produced from the same egg. Many causes may make animal life cognizable by our senses; as the warmth of spring restores the activity of some animals, which were dormant during winter, and which, otherwise, we should not suppose were animals. Others may be dried so as to be preserved from corruption for a long time, and when wet, are restored to life and activity. Others may be made to grow by the stimulus of electricity; as hens' eggs may be hatched by this stimulating power. And it seems probable that many tribes of animalcules are, by some change in the nature of the substance in which they live, made to grow so large as to be seen by the naked eye, though they could not before be seen with a microscope. These considerations should cause us to suspect, when we find animals appearing to originate from inanimate matter, that they existed in it before, and that they were either so small that they could not be seen, or that they were in a state of dormancy; and not to believe that all matter is possessed of the power of perception, appetites, &c., or of real animal life.

U. A. B.

ECONOMICAL OVEN.

We have received the drawing and specification of the above from the patentee. That our readers may more fully understand it, we give the specification at length.

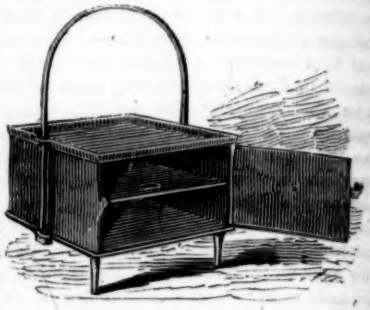
Be it known, that I, Abel Stowell, of Medford, in the county of Middlesex, and State of Massachusetts, have invented a new and useful improvement in the method of baking, or cooking, which I denominate the "Economical Oven"; and that the following is a full and exact description of the construction and operation of said oven, as invented or improved by me:—My said improvement consists in a chest, or oven, (made of iron, or other suitable material,) which may be used for the same purpose as the common baking pan; but, instead of opening at top, by which the articles to be baked, or cooked, are usually inserted or withdrawn, I make a lateral opening, which I close with a door, when the articles to be baked, or cooked, are placed within the oven. I make the upper part of the oven stationary, with a projecting rim at the outer extremities, similar to the common baking pan, for the purpose of retaining coals, or other fuel. I also make a bail and feet, by which the said oven may be suspended over, or placed on the ignited fuel. I likewise make suitable projections within said oven, to receive a movable partition, grid-iron, or other thing, upon which the articles intended to be baked, or cooked, may be placed, either separately or together, with others on the bottom of the oven. This oven may be either of a circular, square, or other form, but I prefer one of a square form, consisting of six plates, or pieces of cast iron. To the under part of the piece which forms the bottom, I attach feet, similar to the common baking pan. On the upper part of said piece, I make grooves, or rabbets, to support the pieces which compose the sides. On the outer part of the upper piece of said oven, I make a projecting rim for the purpose of retaining fuel; on the under part of said piece, I also make grooves, or rabbets, to sustain the sides and top in their required situations. I secure the several pieces of said oven together by causing the lower parts of the bail to pass through lateral projections on the opposite sides of the top and bottom pieces, the said

bail having shoulders, or other stops, which are made to bear on the said projections at the top pieces of the oven, and are screwed, rivetted, or otherwise secured, against the said projections, at the bottom piece. I also connect the door, by hinges, to one of the side pieces, or by making the door with two opposite pintles; at one end I insert one of the pintles through a perforation made at one corner of the bottom piece of said oven, and the other pintle through a similar perforation in the top piece, so that when the different pieces of the oven shall be screwed, or otherwise fastened together, the door may be retained in a suitable situation.

The advantages of this method over the common baking pan, are: that articles may be baked, or cooked, with less consumption of fuel; in a more expeditious and cleanly manner; and that they can be placed within, and taken from, the oven without removing either the oven or fuel, or subjecting the operator to be burned, or scalded, which is a great inconvenience attending the baking pan in common use. By inserting one or more horizontal partitions, several articles may be baked, or cooked, at the same time, or by inserting a gridiron or other suitable support. Beef-steaks, chickens, or other things, may be cooked as well over blazing fuel as over ignited coals.

I would have it understood, that, what I claim as my invention, is an improvement on the common baking pan, by making the openings through which the articles to be baked, or cooked, may be placed within, or withdrawn from the said oven, in a lateral situation, and which opening may be closed by a door connected to the oven, instead of the movable cover as is usual, by which means baking or cooking may be effected in a more economical, cleanly, and expeditious manner, without subjecting the operator to the inconveniences attending the employment of the baking pan, in common use. ABEL STOWELL.

We do not profess to be an adept in the arts of cooking or baking, but as far as our knowledge will allow us to judge, we think Mr. Stowell's improvement a very essential one. Those more skilled will no doubt see the utility of the improvement over the common baking pan. The application of the door at the side, enables a person at any time to witness the effect of the heat on what is within. The trouble which is done away with on this head every one who has used the covered pans must have experienced. We understand it is already for sale by most of the hard ware dealers of the city, and think it will be found in every respect to answer the purpose intended. As our columns are always open for the introduction of new inventions, we have given it room. We wish the invention success, and would cheerfully recommend it to the publick as a highly useful and important article for the kitchen. The following is a representation of it.—ED.]



$4,000 PREMIUM.

The Baltimore and Ohio Rail Road Company, desirous of obtaining a supply of locomotive steam engines of American manufacture, give notice that they will pay Four Thousand Dollars for the most approved engine, delivered for trial on the Road, before the first of June, 1831; and Three Thousand, Five Hundred, for the next best. The following are the conditions:—

1st. The engine must burn coke or coal, and must consume its own smoke.

2d. The engine, when in operation, must not exceed 3½ tons weight, and must, on a level road, be capable of drawing, day by day, 15 tons, inclusive of the weight of the wagons, 15 miles per hour. The Company to furnish wagons of Winans' construction, the friction of which will not exceed 5lbs. to the ton.

3d. In deciding on the relative advantages of the several engines, the Company will take into consideration their respective weights, power and durability, and, all things being equal, will adjudge a preference to the engine weighing the least.

4th. The flanges are to run on the inside of the rails.—The form of the cone and flanges, and the tread of the wheels, must

be such as are now in use on the road. If the working parts are so connected as to work with the adhesion of all the four wheels, then all the wheels shall be of equal diameter, not to exceed three feet; but if the connexion be such as to work with the adhesion of two wheels only, then those two wheels may have a diameter not exceeding 4 feet, and the other two wheels shall be 2½ feet in diameter, and shall work with Winans' friction wheels, which last will be furnished on application to the Company. The flanges to be 4 feet 7½ inches apart from outside to outside.—The wheels to be coupled 4 feet from centre to centre, in order to suit curves of short radius.

5th. The pressure of the steam not to exceed 100lbs. to the square inch, and as a less pressure will be preferred, the Company, in deciding on the advantages of the several engines, will take into consideration their relative degrees of pressure. The Company will be at liberty to put the boiler, fire tube, cylinder, &c. to the test of a pressure of water, not exceeding three times the pressure of the steam intended to be worked, without being answerable for any damage the machine may receive in consequence of such test.

6th. There must be two safety valves, one of which must be completely out of the reach or control of the engine man; and neither of which must be fastened down while the engine is working.

7th. The engine and boiler must be supported on springs, and rest on four wheels, and the height from the ground to the top of the chimney must not exceed 12 feet.

8th. There must be a mercurial guage affixed to the machine, with an index rod, showing the steam pressure above 50lbs. per square inch, and constructed to blow out at 120lbs.

9th. The engines which may appear to offer the greatest advantages will be subjected to the performance of 30 days regular work on the Road; at the end of which time, if they shall have proved durable, and continue to be capable of performing agreeably to their first exhibition, as aforesaid, they will be received and paid for as here stipulated.

N. B. The Rail Road Company will provide and will furnish a tender and supply of water and fuel for the trial.—Persons desirous of examining the Road, or obtaining more minute information, are invited to address themselves to the President of the Company—Philip E. Thomas.

The least radius of curvature of the Road is 400 feet.—Competitors who arrive with their engines before the first of June, will be allowed to make experiments on the Road previous to that day.

EXPANSION.

It may be laid down as a general rule, to which there is no known exception, that every addition or abstraction of calorick makes a corresponding change in the bulk of the body which has been subjected to this alteration in the quantity of its heat. In general the addition of heat increases the bulk of a body, and the abstraction of it diminishes its bulk; but this is not uniformly the case, though the exceptions are not numerous. Indeed these exceptions are not only confined to a very small number of bodies, but even in them they do not hold, except at certain particular temperatures, while at all other temperatures these bodies are increased in bulk when heated, and diminished in bulk by being cooled. We may therefore consider expansion as one of the most general effects of heat. It is certainly one of the most important, as it has furnished us with the means of measuring all the others.

Though all bodies are expanded by heat and contracted by cold, and this expansion in the same body is always proportional to some function of the quantity of calorick added or subtracted; yet the absolute expansion, or contraction, has been found to differ exceedingly in different bodies. In general, the expansion of gaseous bodies is greatest of all; that of liquids is much smaller, and that of solids the smallest of all. Thus, 100 cubick inches of atmospherick air, by being heated from the temperature of 32° to that of 212°, are increased to 137·5 cubick inches; while the same augmentation of temperature only makes 100 cubick inches of water assume the bulk of 104·5 cubick inches; and 100 cubick inches of iron, when heated from 32° to 212°, assume a bulk scarcely exceeding 100·1 cubick inches. From this example, we see that the expansion of air is more than eight times greater than that of water, and the expansion of water about 45 times greater than that of iron.

An accurate knowledge of the expansion of gaseous bodies being frequently of great importance in chymical researches, many experiments have been made to ascertain it; yet, till lately, the problem was unsolved. The results of philosophers were so various

and discordant, that it was impossible to form any opinion on the subject. This was owing to the want of sufficient care in excluding water from the vessels in which the expansion of the gases was measured. The heat which was applied converted portions of this water into vapour, which, mixing with the gas, totally disguised the real changes in bulk which it had undergone. To this circumstance we are to ascribe the difference in the determinations of de Luc, general Roy, Saussure, d'Ivernois, &c. Fortunately the problem has lately engaged the attention of Mr. Dalton of Manchester, and M. Gay Lussac; and their experiments, made with the proper precautions, have solved the problem. Mr. Dalton's experiments are distinguished by a simplicity of apparatus which adds greatly to their value, as it puts it in the power of others to repeat them without difficulty. It consists merely of a glass tube, open at one end, and divided into equal parts; the gas to be examined was introduced into it after being properly dried, and the tube is filled with mercury at the open end to a given point; heat is then applied, and the dilatation is observed by the quantity of mercury which is pushed out. M. Gay Lussac's apparatus is more complicated, but equally precise; and as his experiments were made on larger bulks of air, the coincidence with those of Mr. Dalton adds considerably to the confidence which may be placed in the results.

The expansion of liquid bodies differs from that of the elastick fluids, not only in quantity, but in the want of uniformity with which they expand when equal additions are made to the temperature of each. This difference seems to depend upon the fixity or volatility of the component parts of the liquid bodies; for in general those liquids expand most by a given addition of heat, whose boiling temperatures are lowest, or which contain in them an ingredient which readily assumes the gaseous form. Thus mercury expands less when heated to a given temperature than water, which boils at a heat much inferior to mercury; and alcohol is much more expanded than water, because its boiling temperature is lower. In like manner nitrick acid is much more expanded than sulphurick acid; not only because its boiling point is lower, but because a portion of it has a tendency to assume the form of an elastick fluid. We may consider it therefore as a pretty general fact, that the higher the temperature necessary to cause a liquid to boil, the smaller is the expansion which is produced by the addition of a degree of heat; or, in other words, the expansibility of liquids is nearly inversely as their boiling temperature.

Another circumstance respecting the expansion of liquids deserves particular attention. The expansibility of every one seems to increase with the temperature; or, in other words, the nearer a liquid is to the temperature at which it boils, the greater is the expansion produced by the addition of a degree of calorick; and, on the other hand, the farther it is from the boiling temperature, the smaller is the increase of bulk produced by the addition of a degree of calorick. Hence it happens, that the expansion of those liquids approaches nearest to equability whose boiling temperatures are highest; or, to speak more precisely, the ratio of the expansibility increases the more slowly, the higher the boiling temperature.

The expansion of solid bodies is so small, that a micrometer is necessary to detect the increase of bulk. As far as is known, the expansion is equable, at least the deviation from perfect equality is insensible.

The expansion of glass is a point of great importance, as it influences the result of most experiments on temperature. It has been examined with much precision by M. de Luc. The rate of its expansion, as settled by that philosopher, may be seen in the following table:

Temp.	Bulk.	Temp.	Bulk.	Temp.	Bulk.
32°	100000	100°	100023	167°	100056
50	100006	120	100033	190	100069
70	100014	150	100044	212	100083

From this table it appears, that when glass is heated one degree, it undergoes an expansion which amounts nearly to $\frac{1}{200000}$ of the whole bulk.

Having considered the phenomena and laws of expansion as far as they are understood, it will be proper to state the exceptions to this general effect of heat, or the cases in which expansion is produced not by an increase, but by a diminution of temperature. These exceptions may be divided into two classes. The first class comprehends certain liquid bodies which have a maximum of density corresponding with a certain temperature; and which, if they are heated above that temperature, or cooled down below it, undergo in both cases an expansion or increase of bulk. The second

class comprehends certain liquids which suddenly become solid when cooled down to a certain temperature; and thus solidification is accompanied by an increase of bulk.

Water furnishes us with the most remarkable example of the first class of bodies. Its maximum of density corresponds with 42·5° of Fahrenheit's thermometer, as has been lately ascertained by Mr. Dalton. If it is cooled down below 42·5°, it undergoes an expansion for every degree of temperature which it loses; and 32° the expansion amounts, according to Mr. Dalton, to $\frac{1}{160}$ of the whole expansion which water undergoes when heated from 42·5° to 212°. With this more recent experiments coincide very nearly; for by cooling 100000 parts in bulk of water from 42·5° to 32°, they were converted to 100031 parts. We are indebted to the ingenuity of Mr. Dalton for the discovery of a very unexpected fact, that the expansion of water is the same for any number of degrees above or below the maximum of density. Thus if we heat water ten degrees above 42·5°, it occupies precisely the same bulk as it does when cooled down ten degrees below 42.5°. Therefore the density of water at 32° and at 53° is precisely the same. Mr. Dalton succeeded in cooling water down to the temperature of 5° without freezing, or 37·5° below the maximum point of density; and during the whole of that range, its bulk, precisely corresponds with the bulk of water the same number of degrees above 42·5°. Thus the bulk of water at 5° is the same as the bulk of water at 80°. The scale of expansion, therefore, which has been given for the expansion of water when heated, answers also for its expansion when cooled, provided the table begin at 42·5°, as is done in the table of the expansion of water.

A considerable number of liquids has been tried to ascertain whether any of them, like water, have a temperature in which their density is a maximum, and which expand when cooled below that temperature. Sulphurick acid has no such point, neither have the oily bodies; but some solutions of salt in water begin to expand before they become solid. These solutions, however, when cooled down sufficiently, crystallize with such rapidity, that it is extremely difficult to be certain of the fact, that they really do begin to expand before they crystallize.

That class of bodies which undergo an expansion when they change from a liquid to a solid body by the diminution of temperature, is very numerous. Not only water when converted into ice undergoes such an expansion, but all bodies which by cooling assume the form of crystals.

The prodigious force with which water expands in the act of freezing has been long known to philosophers. Glass bottles filled with water are commonly broken in pieces when the water freezes. The Florentine academicians burst a brass globe whose cavity was an inch in diameter, by filling it with water and freezing it. The force necessary for this effect was calculated by Muschenbroeck at 27720 lbs. But the most complete set of experiments on the expansive force of freezing water are those made by major Williams, at Quebec, and published in the second volume of the Edinburgh Transactions. This expansion has been explained, by supposing it the consequence of a tendency which water, in consolidating, is observed to have to arrange its particles in one determinate manner, so as to form prismatick crystals, crossing each other at angles of 60° and and 120°. The force with which they arrange themselves in this manner must be enormous, since it enables small quantities of water to overcome so great mechanical pressures. Various methods have been tried to ascertain the specifick gravity of ice at 32°; that which succeeded best was to dilute spirits of wine with water till a mass of solid ice put into it remained in any part of the liquid without either sinking or rising. The specifick gravity of such a liquid is 0·92, which of course is the specifick gravity of ice, supposing the specifick gravity of water at 60° to be 1. This is an expansion much greater than water experiences even when heated to 212°. We see from this, that water, when converted into ice, no longer observes that equable expansion measured by Mr. Dalton, but undergoes a very rapid and considerable augmentation of bulk.

The very same expansion is observed during the crystallization of most of the salts; all of them at least which shoot into prismatick forms. Hence the reason that the glass vessels in which such liquids are left, usually break to pieces when the crystals are formed.

This expansion of these bodies cannot be considered as an exception to the general fact, that bodies increase in bulk when heat is added to them, for the expansion is

the consequence, not of the diminution of heat, but of the change in their state from liquids to solids, and the new arrangement of their particles which accompanies or constitutes that change.

It must be observed, however, that all bodies do not expand when they become solid. There are a considerable number which diminish in bulk; and in these the rate of diminution in most cases is rather increased by solidification. When liquid bodies are converted into solids, they either form prismatick crystals, or they form a mass in which no regularity of arrangement can be perceived. In the first case, expansion accompanies solidification; in the second place, contraction accompanies it. Water and all the salts furnish instances of the first, and tallow and oils are examples of the second. In these last bodies the solidification does not take place instantaneously, as in water and salts, but slowly and gradually; they first become viscid, and at last quite solid. Most of the oils, when they solidify, form very regular spheres. The same thing happens to honey, and to some metals. It has been thought that all combustible liquids contract, when they become solid, while incombustible liquids expand; but there are exceptions to this rule. Sulphurick acid does not by congelation alter its appearance; but cast iron, and perhaps sulphur also, expand in the act of congealing.

CAUTION TO WORKERS IN METAL.

Most persons, we believe, are acquainted with the danger attendant upon the sudden contact of heated metals with water, and other liquids. We think, however, but few are aware that *copper*, when melted, is the most dangerous of all metals, under the above circumstances. The following article illustrates the prodigious power of steam, and at the same time conveys salutary information to such as work in the metals.

The writer says there is one particular case from which it has been inferred that aqueous steam is vastly stronger than the flame of gun-powder. This is when water is thrown upon melted copper; for here the explosion is so strong as almost to exceed imagination; and the most terrible accidents have been known to happen from such a slight cause as one of the workmen *spitting in the furnace where copper was melting*. The cause, probably is, that a decomposition of the water takes place, and on this supposition, the phenomenon is easily solved. The water being thrown in substance upon the melted copper, is decomposed by the violent heat; and one part of it adheres to the metal, thus converting it into a kind of calx, while the other is converted into inflammable air, which expanding suddenly, throws the melted metal about with the greatest violence by means of its reaction.

In order to understand the manner in which this is accomplished, we must consider some of the principles of gunnery laid down by Mr. Robins. One of these is, that though the air, in case of ordinary velocity, makes no resistance, it is far otherwise where the velocity of the moving body becomes very great. In all cases of explosion also there is in the first instance a vacuum made by the exploding fluid; and consequently the weight of the atmosphere is to be overcome, which amounts to about 15 pounds on every square inch of surface. Supposing the surface of the exploding fluid then, on that of melted copper, to contain an area of four square inches, it meets with a resistance of 60 pounds from the atmosphere, and consequently communicates an equal pressure to the fluid metal. Even this must of consequence throw it about, unless the same pressure was exactly diffused over every part of the surface. But much more must this effect be increased by the immense velocity with which the fluid moves, and by which the resistance of the atmosphere is augmented in a prodigious degree. The elastick fluid generated is then confined not only by the fluid metal and sides of the furnace, but by the air itself, which cannot get out of the way, so that the whole resembles a cannon closed at the mouth, and filled with inflamed gunpowder. Hence not only the melted metal, but the furnace itself, and the adjacent walls of the building, are hurried off as they would be by the firing of a great quantity of gunpowder in a small space, and which is well known to produce analogous effects.

Dr. Black, in explaining the phenomenon in question, supposes that the mere heat of the metal applied to the aqueous steam produces the explosion; and in proof of this, alleges that copper *imbibes a greater quantity of heat during fusion than any other metal.* Aqueous steam, however, seems to be too slow for producing such sudden and violent effects. Explosions, it is true,

will be occasioned by it, but then it must be confined for a very considerable time, whereas the effects of water thrown upon melted copper are instantaneous.

It must be observed, that in all cases, where a very hot body is thrown upon a small quantity of water in substance, an explosion will follow; but here the water is confined, and suddenly rarefied into steam, which cannot get away without throwing off the body which confines it. Examples of this kind frequently occur where masons, or other mechanicks, are employed in fastening cramps of iron into stones; *where, if there happens to be a little water in the hole into which the lead is poured, the latter will fly out in such a manner as sometimes to burn them severely.* Terrible accidents of this kind have sometimes happened in foundries, *when large quantities of melted metal have been poured into wet moulds.* In these cases, the sudden expansion of the aqueous steam has thrown out the metal with violence; and if any decomposition has taken place at the same time, so as to convert the aqueous into an ærial vapour, the explosion must be still greater.

We selected the above for practical purposes; and add the following paragraphs for the curious:

Another kind of explosion is that which takes place in solid substances, where we can scarcely suppose either aqueous or ærial vapours to be concerned. The most remarkable of these are the volcanick bombs mentioned by sir William Hamilton in the great eruption of Vesuvius in 1779. They were large pieces of lava, which burst in pieces like bombs as they fell to the ground; but he does not inform us whether their bursting was attended with any great violence or not. Indeed, amidst such scenes of horror, and the continual tremendous explosions of the volcano, smaller phenomena of this kind would probably be overlooked.

For the production of explosions, gunpowder is the only substance that has yet been found to answer; nevertheless, as its use is attended with considerable expense, many attempts have been made to find out a cheap substitute for it. One of the most remarkable of these was by mixing small quantities of water inclosed in little bladders, or some easily destructible vehicles, along with a charge of powder. By this contrivance it was hoped that the water, being converted into vapour when the powder was inflamed, would augment the force of the explosion; but instead of this, it was found greatly to diminish it. The reason was evident, viz. that the conversion of the water into steam required so much of the latent heat of the inflamed gunpowder, that enough was not left to give the necessary expansion to the ærial fluid produced.

The effects of explosions, when violent, are felt at a considerable distance, by reason of the concussions they give to the atmosphere; for, as it has been already hinted, all of them act upon the atmospherical fluid with the very same force they exert upon terrestrial substances subjected to their action. Sir William Hamilton relates, that at the explosions of Vesuvius in 1767, the doors and windows of the houses at Naples, flew open, if unbolted, and one door was burst open, though it had been locked. A great quantity of gunpowder being put into the ditch of a fortified city, and set on fire, destroyed part of the wall, and broke down one of the gates. The blowing up of powder-magazines or powder-mills will destroy buildings and kill people, though certainly without the reach of the flame, and untouched by any part of the shattered magazine or mill. But the most curious effect is, that they electrify the air, and even glass-windows, at a considerable distance. This is always observable in firing the guns of the Tower at London; and some years ago after an explosion of some powder-mills in the neighbourhood of that city, a great number of people were alarmed by a rattling and breaking of their china-ware, which by the vulgar was taken for a supernatural phenomenon, but undoubtedly was owing to some commotion in the electrical fluid, from the violent concussion of the atmosphere. In this respect, however, the effects of electrical explosions themselves are most remarkable, though not in the uncommon way just mentioned; but it is certain, that the influence of a flash of lightning is diffused for a great way round the place where the explosion happens, producing many very perceptible changes both ont he animal and vegetable creation.

Dr. Priestley gives an instance of a large fire-ball rolling on the surface of the sea, which, after rising up to the top-mast of a ship of war, burst with such violence, that the explosion resembled the discharge of hundreds of cannons fired at once. Great damage was done by it; but there is not the least doubt that most of its force was spent on the air, or carried down to the sea by the mast and iron-work of the ship.

GAS, AND GAS-LIGHTS.

This subject may be thought by some persons to be more fit for the Philosophick Chymist, than for the general reader, but after a little reflection, they will find that, it is as necessary we should be able to judge of the purity of the air we breathe, as of what we eat or drink.

Gas is the general name given to all *æriform fluids*, except the air of the atmosphere, and vapour or steam. The following are among the most important of the gases.

Oxygen Gas, so called from its relation to *acids*, has been accounted for many reasons, the most important substance in nature. It forms eight-ninths, by weight, of the ocean; one-fourth of the atmosphere; and, perhaps, one-fourth of the solid matter of the globe. It unites readily with most other substances, and assumes a singular variety of character in its different combinations. Thus with *hydrogen*, it forms *water*; with *lead*, it forms the substance called *red-lead*; with *nitrogen*, in one proportion, it forms *atmospheriek air*, in another proportion, the *nitrous oxide*, or what is called the *laughing gas*, in a third the acid called *aquafortis*; with sulphur, it forms the *sulphurick acid*, or *oil of vitriol*; with iron, and all metals, it forms their ores, called oxides; and so forth. But the most important character in which we know it, is as that ingredient of our atmosphere, without which animals and vegetables cannot live, and fire cannot burn. Oxygen, from this part of its history, was long named *vital* or *pure air*. Oxygen gas, is procured from various oxides, especially from the black oxide of manganese.

Nitrogen gas, so called from its relation to *nitrick acid*, is what remains of the atmosphere when the oxygen is removed, it forms about three-fourths of the atmosphere, one-fourth of animal flesh, and is found in small quantities in other combinations. It will not support life by itself, and therefore formerly was called *azote*: with a larger proportion of oxygen it forms nitrick acid.

Hydrogen Gas, so called from its relation to *water*, hydrogen in combination with oxygen, forming that fluid, and being always procured from it, and may be obtained thus: a piece of a tobacco pipe stem, is put through the cork of a bottle, into which put a quantity of iron filings, with about twice its weight of sulphurick acid diluted with four times its bulk of water. As soon as the diluted acid reaches the iron filings, effervescence takes place, and bubbles of gas escape. After allowing time for the common air to be displaced, a light may be applied to the pipe, the gas will burn with a faint light and produce much heat. This gas is the lightest body with which we are acquainted; on this account it is used to fill balloons. It is about 14 times less dense than common air, and 16 times less dense than oxygen gas.

Nitrous gas is procured by pouring diluted nitrick acid on copper filings; its most important property is the greedy attraction that it has for oxygen gas in atmospherick air; on this principle *eudiometers* are formed.

Carbonick acid gas is diffused abundantly in nature, it is found in the state of gas, and also in combination with a great variety of bodies, such as marble, chalk, limestone, &c. By pounding either of these substances and pouring on them diluted sulphurick acid, in a retort or bottle, the gas will be set free, and may be collected with suitable apparatus. Carbonick acid gas is what issues from soda-water, brisk ale, champaign, &c. while they sparkle. If drawn into the lungs, in breathing, it is fatal to life. A charcoal fire left in a close room with sleeping persons, has often been fatal to them, because carbonick acid gas is the product of the combustion. The famous *Grotto del Cane*, in Italy, is a cavern always full of carbonick acid, which springs into it from below, as water springs into a well, and runs over like water from a well. The grotto received its name from the circumstance of dogs dying instantly when thrown into it. Carbonick acid has often proved fatal to persons leaning over fermenting vats, or descending into them soon after the fermented liquor is drawn off. It is common to see a rat die instantly, in the attempt to run along a plank lying across the mouth of a fermenting tub. In a bake-house where there is a considerable quantity of fermenting dough in troughs, it would be dangerous to sleep on the floor; the gas, rising from the dough, fills the trough and runs over the edges, and descends to the floor; being heavier than the air, it always occupies the lowest place. In mines, carbonick acid gas occupies the lower part, and is called the *choke damp*; the common air occupies the middle part; and the upper part of the mine is often occupied by hydrogen gas, called the *fire damp*. Many lives are lost annually by the operation of these gases, particularly the explo-

sions of the fire damp. Safety lamps have been contrived by scientifick men, but experience shows that humanity has not been much benefitted by them as yet.

Carbonick acid gas often collects in wells that remain for some time covered. It has in many instances proved fatal to those who have attempted to descend for the purpose of cleaning the well, or performing some other operation at the bottom. It is always dangerous to descend a well, or vault, or even a deep cellar, that has been long closed up, without the precaution of letting down a lighted candle. If the candle burn with its usual brightness, no danger need be apprehended; but if it burn feebly, or go out, the danger is great. By leaving those cavities open for some time, the carbonick acid gradually mingles with the atmosphere, and safety is restored. A more expeditious way of cleansing them of the deleterious gas, is to let down a quantity of newly slaked lime, in a tub or bucket. The lime rapidly absorbs the acid gas, the place of which is immediately supplied by the atmosphere.

If a suitable pump is at hand, the deleterious gas may be removed in a few minutes; the inhaling pipe should extend to the bottom, or where the gas is most impure; the exhaling pipe should lead to some place where it is lower than the mouth of the well, otherwise the gas, being heavier than common air, will run back into the well.

Carburetted hydrogen gas is used for the purpose of illumination, as an economical substitute for tallow, oil, &c. The materials of which this gas is made, are solid, as sea-coal; or liquid, as oil, or such as may be easily rendered liquid by heat, as pitch, rosin, &c. Of course the apparatus for making the gas, varies in its construction according to the materials to be used in its production. The gas is in general generated in red hot iron retorts, from which it passes through other vessels to be purified, and finally to the gas-holder, whence it is distributed, by various pipes, to the places where it is to be burnt. This gas is invisible like air; it is driven from the gas-holder, like air from a pair of bellows; it issues out at several small holes when it is to be burnt; each burner being furnished with a small stop-cock, to regulate the size of the blaze, or to shut it out entirely. The gas-lights, when properly managed, are both safe, cleanly and economical, for they require no time for trimming, there is no grease nor sparks coming from them, and you have as small a light, or as large a one, as you please, it being so easily regulated.—(Boston Education Reporter.)

ICE KEPT FROM MELTING BY RED HOT LAVA.

A remarkable discovery has lately been made on Etna, of a mass of ice, preserved for many ages, perhaps for centuries, from melting, by the singular event of a current of red hot lava having flowed over it. The following are the facts in attestation of a phenomenon which must at first sight appear of so paradoxical a character. The extraordinary heat experienced in the south of Europe during the summer and autumn of 1828, caused the supplies of snow and ice, which had been preserved in the spring of that year, for the use of Catania and the adjoining parts of Sicily and the neigbouring island of Malta, to fail entirely. Considerable distress was felt for the want of a commodity regarded in these countries as one of the necessaries of life rather than an article of luxury, and on the abundance of which, in some large cities, the salubrity of the water and the general health of the people may be said to depend. The magistrates of Catania applied to Signor M. Gemmelaro, in the hope that his local knowledge of Etna might enable him to point out some crevice or grotto in the mountain where drift snow was still preserved. Nor were they disappointed; for he had long suspected that a small mass of perennial ice at the foot of the highest cone was part of a larger and continuous glacier covered by a lava current. Having procured a large body of workmen, he quarried into this ice, and proved the superposition of the lava for several hundred yards, so as completely to satisfy himself that nothing but the subsequent flowing of the lava over the ice could account for the position of the glacier. Unfortunately for the geologist, the ice was so extremely hard, and the excavation so expensive, that there is no probability of the operation being renewed. On the 1st of December, 1828, I visited this spot, which is on the south-east side of the cone, and not far from the Casa Inglese; but the fresh snow had already nearly filled up the new opening, so that it had only the appearance of the mouth of a grotto. I do not, however, question the accuracy of the conclusion of Signor Gemmelaro, who being well acquainted with all the appearances of drift snow in the fissures and cavities of Etna, had recognized, even before the late exca-

vations, the peculiar position of the ice in this locality. We may suppose, that at the commencement of the eruption, a deep mass of drift snow had been covered by volcanick sand, showered down upon it before the descent of the lava. A dense stratum of this fine dust, mixed with scoriæ, is well known to be an excellent non-conductor of heat, and may thus have preserved the snow from complete fusion when the burning flood poured over it. The shepherds in the higher regions of Etna are accustomed to provide an annual store of snow to supply their flocks with water in the summer months, by simply strewing over the snow in the spring a layer of volcanick sand a few inches thick, which effectually prevents the sun from penetrating. When lava had once consolidated over a glacier at the height of ten thousand feet above the level of the sea, we may readily conceive that the ice would endure as long as the snows of Mont Blanc, unless melted by volcanick heat from below. When I visited the great crater in the beginning of winter, (1828,) I found the crevices in the interior encrusted with thick ice, and in some cases hot vapours were streaming out between masses of ice and the rugged and steep walls of the crater. After the discovery of Signor Gemmelaro, it would not be surprising to find in the cones of the Icelandick volcanos repeated alternations of lava streams and glaciers.—(Lyall's Geology.)

Microscopick Views of Spiders Weaving their Webs.

Of all the beautiful discoveries with which we have become acquainted, through the progress of the physical sciences, there are none more striking than those of the microscope, or which may be studied with greater ease. The application of a powerful lens to any of those minute objects which we have it daily in our power to examine, exhibits a scene of wonder, of which those who have never witnessed it cannot form an adequate idea.

For example, the construction of cobwebs, has in all ages been lightly esteemed: nevertheless, for simplicity of machinery and neatness of execution, they cannot be surpassed by the art of man. The spinners are the apparatus through which by a most wonderful process the spider draws its thread. Each spinner is pierced, like the plate of a wire-drawer, with a multitude of holes, so numerous and exquisitely fine, that a space often not bigger than a pin's point includes above a thousand. Through each of these holes proceeds a thread of an inconceivable tenuity, which, immediately after issuing from the orifice, unites with all the other threads, from the same spinner into one. Hence from each spinner proceeds a compound thread; and these four threads, at the distance of about one tenth of an inch from the apex of the spinner, again unite, and form the thread we are accustomed to see, which the spider uses in forming its web. Thus a spider's web, even spun by the smallest species, and when so fine that it is almost imperceptible to our senses, is not, as we suppose, a single line, but a rope composed of at least four thousand strans.—But to feel all the wonders of this fact, we must follow Leuwenhoeck in one of his calculations on the subject. This renowned microscopick observer found, by an accurate estimation, that the threads of the minutest spiders, some of which are not larger than a grain of sand, are so fine, that four millions of them would not exceed in thickness one of the hairs of his beard! Now we know that each of these threads is composed of above 4,000 still finer. It follows, therefore, that above 16,000 millions of the finest threads which issue from such spiders, are not, altogether, thicker than a human hair.

In the earlier part of last century, Bon, of Languedoc, fabricated a pair of stockings, and a pair of gloves, from the threads of spiders. They were nearly as strong as silk, and of a beautiful grey colour!

Natural Philosophy.—It is well known that the examination of flowers and vegetables of every description by the microscope, opens a new and interesting field of wonders to the inquiring naturalist. Sir John Hill has given the following interesting account of what appeared on his examining a carnation.—The principal flower was a carnation. The fragrance of this led me to enjoy it frequently. The sense of smelling was not the only one effected on these occasions: while that was satiated with the powerful sweet, the ear was constantly attacked by an extremely soft, but agreeable murmuring sound. It was easy to know, that some animal within the covert must be the musician, and that the little noise must come from some little creature, suited to produce it. I instantly distended the lower

part of the flower, and placing it in full light, could discover troops of little insects frisking, with jollity, among the narrow pedestals that supported its leaves, and the little threads that occupied its centre. What a fragrant world for their habitation! What a perfect security from all annoyance in the dark green husk that surrounded the scene of action? Adapting a microscope to take in at one view the whole base of the flower, I gave myself an opportunity of contemplating what they were about, and this for many days together, without giving them the least disturbance. Thus I could discover their economy, their passions, and their enjoyments. The microscope, on this occasion, had given what nature seemed to have denied to the objects of contemplation. The base of the flower extended itself under its influence to a vast plain, the slender stems of the leaves became, as it were, trunks of so many stately cedars; the threads in the middle seemed columns of massy structure, supporting at the top their several ornaments; and the narrow spaces between were enlarged in walks, parterres, and terraces. On the polished bottoms of these, brighter than Parian marble, walked in pairs, alone or in companies, the winged inhabitants; these, from little dusky flies, for such only the naked eye could have shown them, were raised to glorious, glittering animals, stained with lively purple, and with a glossy gold, that would have made all the labours of the loom contemptible in the comparison. I could, at leisure, as they walked together, admire their elegant limbs, their velvet shoulders, and their silken wings; their backs vying with the empyrean in its blue; and their eyes, each formed of a thousand others, out-glittering the little planes on a brilliant. I could observe them singling out their favourite females; courting them with the musick of their buzzing wings, with little songs, formed for their little organs, leading them from walk to walk, among the perfumed shades, and pointing out to their taste the drop of liquid nectar, just bursting from some vein within the living trunk. Here were the perfumed groves, the more than mystick shades of the poet's fancy realized. Here the happy lovers spent their days in joyful dalliance, or in the triumph of their little hearts, skipped after one another, from stem to stem, among the painted trees, or winged their short flight to the close shadow of some broader leaf, to revel undisturbed in the height of all felicity.

The Viper's Fang.—The fang of a viper is a clear and curious example of mechanical contrivance. It is a perforated tooth, loose at the root; in its quiet state lying down flat upon the jaw, but furnished with a muscle, which, with a jerk, and by the pluck, as it were, of a string, suddenly erects it. Under the tooth close to its root, and communicating with the perforation, lies a small bag containing the venom. When the fang is raised, the closing of the jaw presses its root against the bag underneath; and the force of this compression sends out the fluid, and with a considerable impetus, through the tube in the middle of the tooth. What more unequivocal or effectual apparatus could be devised, for the double purpose of at once inflicting the wound and injecting the poison? Yet though lodged in the mouth, it is so constituted as in its inoffensive and quiescent state, not to interfere with the animal's ordinary office of receiving its food. It has been observed also, that none of the harmless serpents, the black snake, the blind worm, &c. have these fangs, but teeth of an equal size; not movable as this is, but fixed in the jaw.

SPONTANEOUS COMBUSTION.

Dr. Peter Schofield, in a late address delivered at the formation of a Temperance Society in the township of Bastard, in the district of Johnstown, in the province of Upper Canada, states a case of spontaneous combustion which occurred in his practice. "It is well authenticated," says the Doctor, "that many habitual drunkards of ardent spirits are brought to their end by what is called spontaneous combustion. I mean, when a person takes fire, as by an electrick shock, and burns up without any external application. Trotter mentions several such instances. One happened under my own observation. It was the case of a young man, about twenty-five years old. He had been an habitual drunkard many years. I saw him about nine o'clock in the evening on which it happened. He was then, as usual, not drunk, but full of liquor. About eleven on the same evening, I was called to see him. I found him literally roasted, from the crown of his head to the sole of his foot. He was found in a blacksmith's shop just across the way from where he had been. The owner, all of a sudden, discovered an extensive light in his shop, as though the whole building was in one general flame. He ran with the greatest precipitancy, and on flinging open the door, discovered a man standing erect, in the midst of a widely extended silver-coloured blaze, bearing, as he described it, exactly the appearance of the wick of a burning candle, in the midst of its own flame. He seized him by the shoulder, and jerked him to the door, upon which the flame was instantly extinguished. There

was no fire in the shop, neither was there any possibility of fire having been communicated to him from any external source. It was purely a case of spontaneous ignition. A general sloughing came on, and his flesh was consumed or removed in the dressing, leaving the bones and a few of the larger blood-vessels standing. The blood, nevertheless, rallied round the heart, and maintained the vital spark, until the thirteenth day, when he died, not only the most noisome, ill-featured, and dreadful picture that was ever presented to human view; but his shrieks, his cries and lamentations, were enough to rend the heart of adamant. He complained of no pain of body—his flesh was gone. He said he was suffering the torments of hell; that he was just upon its threshhold, and should soon enter its dismal caverns; and in this frame of mind he gave up the ghost. O the death of a drunkard! Well may it be said to exceed all description. I have seen other drunkards die, but never in a manner so awful and affecting."

We have often been asked to give receipts for various compositions, particularly for varnishes. We think the following may satisfy the requests of some of our friends.

Fat Oil Varnish.

Fixed or fat oil will not evaporate; nor will it become dry of itself. To make it dry, it must be boiled with metallick calces or oxides. Litharge is generally used for this purpose. Oil so prepared is called *drying-oil.* To accelerate the drying of oil varnish, oil of turpentine is added.

Gum-copal and amber are the substances principally employed in oil varnishes; the copal being whitest, is used for varnishing light, the amber for dark colours.

It is best to dissolve them before mixing them with the oil; because, by this means, they are in less danger of being scorched, and at the same time the varnish is more beautiful. They should be melted in an iron pot over the fire: they are in a proper state for receiving the oil when they give no resistance to the iron spatula, and when they run off from it drop by drop.

To make oil varnish, pour four, six, or eight ounces of drying-oil among sixteen ounces of melted copal, or amber, by little and little, constantly stirring the ingredients at the same time, with the spatula. When the oil is well mixed with the copal or amber, take it off the fire; and when it is pretty cool, pour in sixteen ounces of the essence of Venice turpentine. After the varnish is made, it should be passed through a linen cloth.

Oil varnishes become thick by keeping; but when they are to be used, it is only necessary to pour in a little Venice turpentine, and to put them a little on the fire. Less turpentine is necessary in the summer than in the winter: too much oil hinders the varnish from drying; but when too little is used, it cracks, and does not spread properly.

Black Varnish, for Coaches and Iron-Work.

This varnish is composed of asphaltum, resin, and amber, melted separately, and afterwards mixed; the oil is then added, and afterwards the turpentine, as directed above. The usual proportions are, twelve ounces of amber, two of resin, two of asphaltum, six of oil, and twelve of turpentine.

A Varnish for rendering Silk, water and air-tight.

To render the linseed-oil drying, boil it with two ounces of sugar of lead, and three ounces of litharge, for every pint of oil, till the oil has dissolved them; then put a pound of bird-lime, and half a pint of the drying-oil into a pot of iron or copper, holding about a gallon; and let it boil gently over a slow charcoal fire, till the bird-lime ceases to crackle; then pour upon it two pints and a half of drying-oil, and boil it for about an hour longer, stirring it often with an iron or wooden spatula. As the varnish in boiling swells much, the pot should be removed from the fire, and replaced when the varnish subsides. While it is boiling, it should be occasionally examined, in order to determine whether it has boiled enough. For this purpose, take some off it upon the blade of a large knife, and after rubbing the blade of another knife upon it, separate the knives; and when, on their separation, the varnish begins to form threads between the two knives, it has boiled enough, and should be removed from the fire. When it is almost cold, add about an equal quantity of spirits of turpentine; mix both well together, and let the mass rest till the next day; then having warmed it a little, strain and bottle it. If it is too thick, add spirits of turpentine. This varnish should be laid upon the stuff when perfectly dry, in a lukewarm state; a thin coat of it upon one side, and, about twelve hours after, two other coats should be laid on, one on each side; and in twenty-four hours the silk may be used.

A Varnish for Toilet-Boxes, Cases, Fans, &c.

Dissolve two ounces of gum mastich, and eight ounces of gum sandarach, in a quart of alcohol; then add four ounces of Venice turpentine.

A Varnish for Violins and other Musical Instruments.

Put four ounces of gum sandarach, two ounces of lac, two ounces of gum mastich, an ounce of gum elemi, into a quart of alcohol, and hang them over a slow fire till they are dissolved; then add two ounces of turpentine.

Seed-lac Varnish.

Take spirits of wine, one quart; put it in a wide-mouthed bottle, add thereto eight ounces of seed-lac, that is large grained,

bright and clear, free from dirt and sticks; let it stand two days, or longer, in a warm place, often shaking it. Strain it through a flannel into another bottle, and it is fit for use.

Shell-lac Varnish.

Take one quart of spirits of wine, eight ounces of the thinnest and most transparent shell-lac, which, if melted in the flame of a candle, will draw out in the longest and finest hair; mix and shake these together, and let them stand in a warm place for two days, and it is ready for use. This varnish is softer than that which is made from seed-lac, and, therefore, is not so useful; but may be mixed with it for varnishing wood, &c.

White Varnish, for Clock Faces, &c.

Take of spirits of wine, highly rectified, 1 pint, which divide into four parts; then mix one part with half an ounce of gum mastich, in a phial by itself; one part of spirits, and half an ounce of gum sandarach, in another phial; one part of spirits, and half an ounce of the whitest parts of gum-benjamin. Then mix and temper them to your mind. It would not be amiss to add a little bit of white resin, or clear Venice turpentine, in the mastich bottle; it will assist in giving a gloss. If your varnish prove too strong and thick, add spirits of wine only; if too hard, some dissolved mastich; if too soft, some sandarach or benjamin. No other rule can be given, unless the quality of the gums and the spirits could be ascertained. When you have brought it to a proper temper, warm the silvered plate before the fire, (if a clock face, taking care not to melt the wax,) and with a flat camel's hair pencil, stroke it all over until no white streaks appear. This will preserve silvering many years.

A Mode of Drying Damp Walls.—It very often happens that apartments on the ground floor, particularly if the house be situated near a common sewer, or other receptacle for filth, are so damp that they cannot be successfully papered, the paper soon moulders and decays. To remedy such an evil, the following plan is recommended in a French Journal:—

There was a large room, the walls of which were always damp, and after a variety of means had been tried to render them dry, it was resolved to pull them down. Under these circumstances it was recommended to wash them with sulphurick acid, which was done.—The deliquescent salts were decomposed, and the room was afterwards perfectly dry. No doubt, after using the sulphurick acid, the walls ought to be washed several times with pure water, to carry off all the acid and salts.

Warts, are sometimes the effect of a particular fault in the blood, which feeds and extrudes a surprising quantity of them. This happens to some children, from nine to ten years old, and especially to those who feed most plentifully on milk, or milk meats. They may be removed by a moderate change of their diet, and pills made of equal parts of rhubarb and compound extract of colocynth. But they are more frequently an accidental disorder of the skin, arising from some external cause. In this last, if they are very troublesome in consequence of their great size, their situation, or their long standing, they may be destroyed. 1. By tying them closely with a silk thread, or with a strong flaxen one, waxed. 2. By cutting them off with a sharp scissors, and applying a plaster of diachylon with the gums over the cut wart, which brings on a small suppuration, that may dissolve or destroy the root of the wart. 3. By drying, or as it were, withering them up by some moderate corroding application, such as that of the milky juice of purslain, of fig-leaves, of swallow wort, or of spurge. But besides these corroding vegetable milks being procurable only in summer, people who have very delicate thin skins should not make use of them, as they may occasion a considerable and painful swelling. Strong vinegar, charged with as much common salt as it will dissolve, is a very proper application to them. A plaster may also be composed from sal ammoniac, and some galbanum, which being kneaded up well together and applied, seldom fails of destroying them. The most powerful corrosives should never be used without the direction of a surgeon; and even then, it is full as prudent not to meddle with them, any more than with actual cauteries. We have lately seen some very tedious and troublesome disorders and ulcerations of the kidneys ensue on the application of a corrosive water, by the advice of a quack. Cutting them away is a more certain, a less painful, and a less dangerous way of removing them.

PROJECTILES—EXTRAORDINARY.

[The effect described in the first part of the following communication, for which we are indebted to an officer of the army, and an eye-witness, is so extremely peculiar, that we feel induced to point it out to the attention of our scientifick readers, as well worthy of investigation.—Edit. Lond. M. Mag.]

The natives of New South Wales have the art of throwing a curved flat stick, made

of very heavy wood, and in the form of a crescent, with such force and accuracy, as to break a man's leg at sixty or eighty yards; but the strange peculiarity of it is, that it can also be thrown to the distance of a hundred yards and upwards in the air, and, without striking any thing, will return to the person who threw it, and even pass beyond him twenty or thirty yards. A similar stick is used by a people to the southward of Trichinopoly, the Colareese; they, however, only use it for straight-forward purposes, and do not understand how to make it return. Captain Cook, when at Botany Bay, having seen the Bomarang, concluded it was a wooden sword; and under that idea, conjectured that the natives of New South Wales were descended from Malays, from the supposed similarity of the Bomarang to the Malay sword. The New Hollanders also have a method of discharging their spears, which surpasses any other that I have heard or read of. The spears they use are from seven to eight feet long, and they are cast by means of a flat stick called a Womora, about a yard in length, with a sort of hook at the point of it, on which the hinder end of the spear rests; this stick acts as a sling, or lever; by this means the spear can be thrown to the distance of a hundred and twenty yards: with the hand alone, the spear cannot be thrown beyond fifty yards. J. N.

NAVIGATION OF THE OHIO.

A memorial is circulating for signature in the West, praying Congress for an appropriation to improve the navigation of the Ohio. It is thought practicable to render that river navigable throughout the summer and autumn, between Louisville and its mouth, by boats drawing four feet water; and between Louisville and Pittsburg, by boats drawing three feet. Capt. Shreve's experiment this year seems to demonstrate that this can be speedily and cheaply done. By the construction of a wing-dam at the Grand Chain, five hundred and seventy-five yards in length, the width of the channel has been diminished to twelve hundred feet, and the depth of the main channel increased, from twenty-two inches to four feet; and the work cost less than $600.

Between the mouth of Ohio and Louisville there are sixty-one bars or shoals, which may be so improved by the construction of wing-dams as to render the channel four feet deep on each, at the lowest stage of the river, and the entire expense will not exceed $75,000. The timber and rocks now obstructing the river may be used in the construction of these dams, which will last for centuries. So, also, from Louisville to Pittsburg, the same plan will make the river navigable at all seasons, for vessels drawing three feet, at a cost which cannot exceed $250,000. The aggregate cost of the two branches of this improvement would therefore be $325,000.

Its importance may be estimated from the fact, that during the last five months, the communication by steam having been effectually cut off between Pittsburg and Wheeling and Louisville, the freight of the immense importations from the eastern cities has been one dollar the hundred pounds; the voyage down has been protracted to thirty or forty days, and immense losses have been sustained from the boats being run upon logs and rocks. Could the boats have run, the freights would not have exceeded thirty cents the hundred pounds,—a saving of $14 a ton: to say nothing of the losses. The Mail, likewise, might then be carried by packets between Pittsburg and New Orleans. It is added that "the completion of the Ohio and Pennsylvania Canals, and the Baltimore and Ohio Rail Road will, it is believed, have the effect of doubling the amount of transportation on the Ohio river between Louisville, Wheeling and Pittsburg."—(Baltimore American.)

Mr. Editor,—In regard to the churns, your "hint" has received due attention, for, upon "looking at the thing again," I find I am wrong, inasmuch as the inference which follows,—"one shaft, with its dashers, turns from *east* to *west*, while the other turns in a contrary direction,"—is unsupported. The wrong idea undoubtedly arose from the expressions, used in the Geneva Gazette, "*the one forward, and the other backward*," and "*by their contrary motion.*" That the shafts and dashers both turn in the same direction is plain from the description, they being turned by an intermediate wheel. When two wheels are geered together they turn in contrary directions; if a third wheel be added, it will move in the same direction as the first. So that the dashers passing between the shafts and the sides of the tube, tend to produce a rotary motion in the cream, while those passing between the two shafts, crossing each others paths, tend to destroy such motion.

A Friend to Real Improvement.

Errata.—At p. 364, 11 lines from the bottom of the first column, read *image*, instead of *mage*.